The Small Computer Magazine

kilobaud™

Understandable for beginners . . . interesting for experts

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More and more, you see the North Star HORIZON computer at work: in business, research, and education. Its high performance qualifies the HORIZON for demanding professional applications. Over 10,000 users during the past two years have proven that North Star hardware has the reliability for day-in, day-out computing. The HORIZON is now a serious candidate for any small system installation.

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PUBLISHER'S REMARKS

Wayne Green

The S-100 Mystique

When Mits came out with their 100-line bus there was a lot of bitching. Connectors were very expensive; it had more lines than were actually needed; it both generated radio hash by virtue of being wide open and it was very susceptible to interference from radio or other noise. In general, it left a lot of unhappy engineers.

Then came Imsai and their pseudo-Altair, also using the 100-line bus. Then PolyMorphic, Processor Tech, S.D. Sales, Godbout, Seals . . . and the first thing you know we had a standard: the S-100. This was one of the better things that happened to microcomputing because it made it possible for many small firms to design interface boards that would work with a wide variety of systems . . . providing music, graphics, art, telephone interconnect, speech, voice recognition, plotting, control of high-power devices, etc.

The time it would have required to custom design each of hundreds of interface boards to fit each new microcomputer system brought out would have put board prices out of sight and thus allowed the support of only a very few systems.

The first to fight this standardization was Sphere, and this undoubtedly contributed much to their collapse. Then came The Digital Group. Is there any serious question that their refusing to use the S-100 bus held their sales down substantially? Only the very limited accessories they themselves provide are available to expand a system. This is terribly limiting.

Why would a firm oppose the S-100 bus structure?

Since most of the original complaints against the bus have been taken care of, the main reason for not using the standard bus today seems to be the manufacturers' desire to force customers to buy their peripherals and not be able to use those of other firms. Depending on which side of the pocketbook you are on, this can be explained as practical marketing or greed.

First, in case there are some new readers who are not really sure what a bus is, a few words on that. Most electronic equipment is designed linearly, with perhaps a very weak oscillator generating a signal at one end, going through many steps of amplification and modulation, finally reaching the antenna. About all the many stages in these systems have in common is a power supply, so the bus is simple . . . plus and minus. Computers are generally built around a whole set of interconnecting wires (a bus) and each of the stages involved plugs into this bus. Signals sent over the bus turn on or off each of the modules. Thus it is possible to have a video terminal, a printer, a cassette tape system and several other input/output devices all connected to a computer and all sharing the same wires. (For more information about buses, see Erich Pfeiffer's article on p. 94.)

The S-100 complaints were loud and bitter at first . . . and rightly so. The Altair system just barely worked (on a good day) because this bus system was so noisy. Often, by the time you got out toward the end slots of a motherboard, things would go berserk.

Gripes about connector prices dropped off as more and more systems used the 100-pin monster. Costs of production generally drop about 15 percent for every doubling of production, so S-100 connector prices dropped and dropped, eventually bringing them below those of much smaller connectors. So much for that beef.

George Morrow and Harry Garland tackled the noise problems and both came up with nicely designed motherboards that were well shielded and greatly tamed the wild bus. Morrow's is in his Thinker Toys Wunderbus and the Godbout motherboard, which he also designed . . . Garland's is in his Cromemco systems.

George also came up with a dandy termination scheme (also in the Extensys) that helped keep signals from bouncing back and forth on a bus line. These evolutions of the S-100 made it possible to greatly extend the upper frequency limit for the system, allowing it to work with the higher speed Z-80 systems.

The S-100 bus is far from perfect, yet it would not seem to have any serious disadvantages as compared to a 40-, 44- or 50-pin bus. Higher frequency signals will eventually mean stripline techniques or coax systems, not fewer lines. The S-100 has room for further growth, a feature sadly missing from most other bus systems. And who knows what interface someone will invent next month and the external cables it will have to use because the bus had standing room only?

When The Digital Group decided not to use the S-100 bus it was because they wanted to try to be the sole suppliers of hardware for their system. Ohio Scientific had the same idea in mind . . . carrying this one step further by refusing to give out information to anyone on the signal timing on their bus. This seems to have worked since there are few (if any) OSI-compatible accessories. This means that the owners of OSI equipment have to wait for OSI to engineer and bring out all I/O boards . . . for music, art, telephone interconnect, etc. Thus the work of a hundred small companies has to be tackled by the mainframe manufacturer . . . a formidable task.

With perhaps 90 percent of the systems on the market S-100 oriented—and that's the way it was in the summer of 1977—the nonstandard bus systems were having a very difficult time. Then came the Heath H8 and their own bus system. Heath agonized over this and was relieved to hear that Commodore had avoided the S-100 bus with their PET. Actually, Heath celebrated a bit early on that one since their kit systems were hobbyist oriented and the PET was not.

It would surprise me if Heath wouldn't have sold many millions of dollars' more of H8 systems if they had gone the S-100 route. It wouldn't have made that much difference in PET sales. The appearance of the Radio Shack system with still another bus, though it may have comforted Heath, did not help Heath sales.

As we approach the end of 1978, with TRS-80 sales greater than those of all other systems combined, there is some reason to wonder if the TRS-80 bus system may not become the de facto standard. Maybe. For some reason the small manufacturers have been slow to adapt to this new bus. Perhaps they have not recognized the wallop of the TRS-80 on the market. Perhaps it has been the usual engineering delays. But at this time, the S-100 is still the best bet for someone who wants to be able to use a system for a large number of purposes.

Radio Shack has a TRS-100 board coming . . . supposed to be out in September. This will plug into an S-100 motherboard and let you run S-100 I/O boards with your TRS-80. When this is out it could change everything and re-emphasize the importance of the S-100 system . . . and save an awful lot of time and money on re-engineering boards to work with the TRS-80.

With Radio Shack and their 100,000 TRS-80 systems added to the S-100 bus line, times may get rougher for maverick bus systems such as the Apple, Heath, OSI, SWTP, etc.

Any arguments?

What Is TI Up To?

Despite Pentagon-like security measures, word has been seeping out about the new Texas Instruments project. Of course, as with any tight security matter, there is always the likelihood of bum dope being passed along to confuse things.

At any rate, it does appear that TI has a 16-bit microcomputer based upon the 9900 chip being readied for consumer sale. This will be selling for under $300, complete with its keyboard and BASIC. There is a strong possibility that it will also support PASCAL, which is a matter of policy with TI.

The 9900 microprocessor has not seen much use in microcomputers so far, so many computerists are not all that aware of its possibilities. This chip is particularly well suited to interfacing with the outside world and should be a natural for controlling things. It has a register that is able to keep track of time without interfering with other operations of the system. It also has the ability to sit dormant, drawing very little power until an interrupt starts it in action.

Although there has been little use for the benefits of a 16-bit processor in microcomputing applications so far, the extra speed of the 9900 certainly is not going to hurt. Remember that an 8-bit processor must take two cycles for the address and one for data, while the 16-bit system addresses in one cycle and loads or retrieves two bytes in one cycle . . . which

adds up to about six times the work in the same time.

More Tutorials Needed?

A recent letter from a software service offering I'm not sure what pointed up the need for more tutorial articles on the fundamentals of computers. Many of us have a long, long way to go before we can even read the ads and understand what is being offered.

Just to break the accepted computer code of ethics and offer a specific example of what I'm talking about, this letter is offering APL (or APL.SV) as an interpreter because of its dynamic allocation properties. Huh? Then it helpfully goes on to offer PASCAL and informs me that traditionally PASCAL is implemented in the language of a pseudo stack machine. Golly, I didn't know that!

Then the letter suggests that perhaps I need a disk operating system with virtual memory mapping. Would that put an end to my troubles? Will I ever find out? Even more exciting is the offer of an assembler generator that would allow me to generate families of assemblers . . . and this gem includes recursive macros.

The letter was enthusiastic, so it may well have a cornucopia of wonders for me . . . if only I knew what it was talking about. Let's get some articles written that will help us decipher this gobbledygook. It only takes a few paragraphs to explain these esoteric terms and give specific examples that all of us can relate to our experience. The sad part is that the writer of the letter was unaware that he was unreadable.

PET Papers

At one time I hoped I would be able to publish enough information about each system available so there would be no need for user groups and their newsletters. That was when there were only two or three computer systems. Today, with four major newsletters devoted to the PET, such a concept is obviously ridiculous. There is just far too much information to exchange.

We have the "PET Gazette," already in issue #4, running 40 pages. The address is 1929 Northport Drive, Room 6, Madison WI 53704. The subscription is free. Then there is "The PET Paper," Box 43, Audubon PA 19407, at $15 for ten issues . . . 30 pages last issue. Also "PET Users Notes," Box 379, South Bound Brook NJ 08880. There is some ambiguity on the address, so write before sending money. Another is "SPHINX," running 19 pages last issue and existing on donations. Write Milt Lee, 1348 Rudgear Rd., Walnut Creek CA 94596.

These newsletters let you know about available software, hardware, modifications, fixes for problems, pertinent books, etc.

Reader Responsibility

One of your responsibilities, as a reader of *Kilobaud*, is to aid and abet the increasing of circulation and advertising, both of which will bring you the same benefit: a larger and even better magazine. You can help by encouraging your friends to subscribe to *Kilobaud*. Remember that subscriptions are guaranteed—money back if not delighted, so no one can lose. You can also help by tearing out one of the cards just inside the back cover and circling the replies you'd like to see: catalogs, spec sheets, etc. Advertisers put a lot of trust in these reader requests for information. To make it even more worth your while to send in the card, a drawing will be held each month and the winner will get a lifetime subscription to *Kilobaud*!

The above notice tells the story. This month's winner of a lifetime subscription to *Kilobaud* is M. Bernstein of Cambridge MA.

AROUND THE INDUSTRY

Radio Shack To Open 50 Computer Centers

Radio Shack plans to open 50 computer sales and service stores in 1978-79. "While some will be located within new or existing Radio Shack stores, most will be separate entities and all are expected to be in major markets," said Lewis Kornfield, president of Radio Shack.

"They will be called Radio Shack Computer Centers, and their purpose will be to assist area Radio Shack stores in answering computer questions and closing sales, and to develop quantity sales, principally of Radio Shack TRS-80 microcomputer systems and peripheral equipment, to businesses and institutions.

"The stores will provide market area service on Radio Shack computer products, thus extending to nearly 100 the number of service facilities operated by Radio Shack in this country, and will include classroom areas where the company can teach computer use and programming to its customers and prospects."

In addition, the new Radio Shack Computer Centers will display and sell "a variety of pieces and parts, as well as packaged software and, possibly, hardware items of makes other than Radio Shack," Kornfeld continued.

"In respect to the significant number of TRS-80 personal computers we have sold, we believe the time is right to quickly expand our ability to keep them in top working order and provide solid local know-how for our customers and employees alike.

"We have converted the former Tandy Computer store, located in Fort Worth, into a Radio Shack Computer Center, and are in the process of indentifying the other 49 or so cities and exact locations.

"To date we have selected our

(continued on page 128)

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NEW PRODUCTS

Edited by Dennis Brisson

IRC's Miserly Mainframe

If you are looking for an S-100 bus mainframe without frills, solidly built and ready to go, take a look at Integrand Research Corporation's Model 800 Miserly Mainframe. These enclosures come complete with a 15-slot motherboard (connectors optional), plastic card guides, a choice of two different capacity power supplies, fan, line cord, fuses, EMI filter and front panel power and reset switches. The Model 800 comes in desk top and rack mount versions, with an option of two color schemes (light blue/dark blue or beige/brown).

The entire unit comes assembled, wired and tested. The power supply is dismounted after testing and shipped in a separate container via UPS. Reassembly consists of mounting the power supply and plugging it into two wiring harnesses.

The chassis is constructed of heavy gauge aluminum, to which high-quality industrial enamel is spray-painted. Interior surfaces are coated with an irridite finish to resist oxidation.

In the rack mount version, the Miserly Mainframe is priced at $200; the desk top version costs $235. The heavy-duty power supply option, which includes a 110 cfm fan instead of the standard 70 cfm fan, is $85. The standard power supply is conservatively rated at 15 A; the heavy-duty power supply will easily handle a load of 30 A. Both ratings are for the 8 V dc line. Integrand Research will install 100-pin connectors for $6 each, or you can buy them for $5 each and install them yourself.

Other options provided include rear panel cutouts for EIA-type *DB-25* connectors. The first four are standard; the next eight cost *$2 each. They* will also provide a voltage monitor board ($30) which generates a relay closure when the ac supply level falls below predetermined limits (great for driving an interrupt to stop processing during power fluctuations, or whatever!).

The extras that are included in the basic price of the Miserly Mainframe, coupled with the fact that it comes assembled and tested, make it the most cost-effective S-100 bus enclosure I've seen. Add to that the options that are available and floppy-disk drive covers, cabinets and power supplies, and you have the most attractive basis for a system on the market. After they did all that for the S-100 bus, they went one step further and added an SWTP-compatible motherboard. Fantastic!

For more information, or to order, contact Integrand Research Corp., 8474 Avenue 296, Visalia CA 93277, (209) 733-9288.

Ron Burris
Associate Editor

Double and Quad Density

North Star Computers, Inc., announces development of a new controller board that can record in double density on the new Shugart SA-400L (single-sided, double density) and SA-450 (double-sided, double density) minifloppies. The controller board formats the SA-400L for 180K bytes (ten 512 byte sectors on each of 35 tracks) and the SA-450 for 360K bytes (same as SA-400L, but with two sides). Thus, a three-drive system with SA-450 minifloppies can access more than a megabyte on-line. North Star's double and quadruple density expands the performance and information storage of the North Star Horizon computer and Micro Disk System. A quad density (SA-450) version of the North Star Horizon and MDS systems will be available in January 1979. This quad version will be offered for $200 additional or $1799 for Horizon-1 kit and $899 for MDS-A kit. Additional drives for quad capacity will be $499.

The new controller board can control any combination of SA-400L and SA-450 drives in single density or double density. It can read diskettes previously written in single density. Also, it permits the attachment of single-density SA-400L drives previously acquired for the original North Star systems.

North Star is upgrading its popular BASIC and DOS to accommodate the increased capacity and the performance of the SA-400L and SA-450 disk drives. Programs developed on the original single-density North Star software will run in double density with little or no change. A quad capacity additional drive may be added to a double-density system at any time.

North Star Computers, Inc., 2547 Ninth Street, Berkeley CA 94710.

Arian System for North Star Disk

The Arian Assembly Language Programming System is designed specifically for North Star Disk users. With Arian, you may save and load both source and object files to disk. With Arian's dynamic file creation, saving a program is simply a matter of typing 'SAVE <FILENAME>'. Arian creates the file on disk if it does not already exist and saves the program. From Arian, you may list the disk directory (DDIR), rename a disk file (DNAM), delete a disk file (DDEL) and recover a deleted file (RCVR).

Editing is a breeze with Arian's input line editor. You may enter text (without the need for irksome line numbers), insert (INS) and find a string (FIND). Intra-line editing is supported by a full complement of features: skip to end of line, insert characters, delete characters, replace (direct substitution) and press the space bar to move character by character through the line.

Arian also supports many capable features and subroutines which are nested inside and are callable by the user. Arian maintains two separate symbol tables —one for the system and one for the user. However, the user may use the system symbols without restriction. The system supports redirectable I/O, conversion of ASCII to hex, and vice versa, print a line of text, output a CR, call the input line buffer, plus many others. Up to eight breakpoints can be used at one time, and all registers are preserved.

A special feature of Arian is its 'CUSTOM COMMAND' capability, by which you may define a command, name it and then call it simply by typing the command name. This is especially useful if you are testing programs. The price ($50) includes one disk and a 51-page User's Manual.

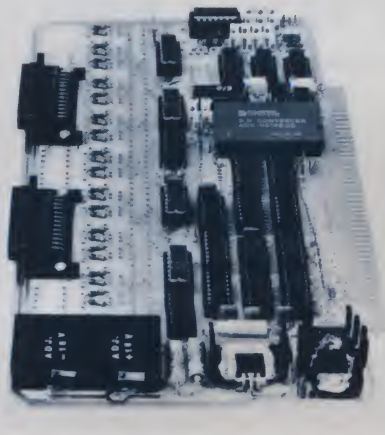
Supersoft, PO Box 1628, Champaign IL 61820.

The S-100-Compatible AIB

The AIB (analog input board) is an S-100-bus-compatible analog input subsystem that accepts multiple low-level analog signals, multiplexes and converts to digi-



North Star's new controller board.



SL's analog input board.

tal format with 12-bit resolution and throughput rates up to 8 kHz. The standard AIB accepts eight differential/16 single-ended inputs and is optionally expandable to 16 differential/32 single-ended.

Other AIB options include computer programmable gain, 4-20 mA current inputs and super low drift. The AIB is priced at $495 in small quantities and deliverable within 30 days.

Signal Laboratories, Inc., 202 N. State College Blvd., Orange CA 92668.

Interpreter for the 8080 and PDP-11

An interpreter for a subset of the C-structured programming language, which runs on both DEC PDP-11 and Intel 8080 processors, is available from Tiny-c Associates, PO Box 269, Holmdel NJ 07733. The tiny-c Owner's Manual includes a complete reference description of the language, a tutorial walkthrough of a training program, lots of sample programs, including comments on their programming style, and a description of the Program Preparation System. It also includes commented source code listings of both the 8080 and PDP-11 interpreters and a chapter on how the interpreter works.

Tiny-c, intended primarily for the education and hobbyist markets, handles integer and character data and arrays of either type. Other features include compound statements, if-else and while statements, global and local variables, pointer variables and functions which may have arguments and may return results. Recursion is allowed. The interpreter also recognizes calls to functions written in machine language. These, too, may have arguments and return results. A minimum of 16K bytes of memory is recommended to run tiny-c.

The package includes a Program Preparation System (PPS) with which the user can write, edit, run, debug, store, recall and link tiny-c programs. The PPS includes a standard library of tiny-c software tools. The PPS is written in tiny-c; thus, it serves as an example of a significant use of tiny-c and is also easily adapted to a user's or operating system's requirements.

The Owner's Manual is available for $40; machine readable copies of the interpreter are available separately on several formats of tape and disk.



Tiny-c cornucopia.



The NewO Writehander.

Dual Floppy-Disk System

Dual-Stor, a fully integrated, dual floppy-disk system designed specifically for microcomputer systems, comes complete with controller and dual floppy-disk drive in a cabinet that matches the Vector 1 microcomputer. The Dual-Stor disk system has a storage capacity of 243K bytes per 8-inch diskette and utilizes the standard IBM-compatible recording format. Using programmed data transfer, the Dual-Stor operates with both static and dynamic memories at a data rate of 250K bits/seconds.

Completely compatible with the S-100 bus, the disk system features the Reset-and-Go function on power up. Other features include state-of-the-art technology, extensive testing and reliability. Tested and assembled, the Dual-Stor comes complete with disk controller board, DOS, BASIC compiler, assembler, string-oriented editor and debug software. Suggested retail price is $2300.

Vector Graphic, Inc., 31364 Via Colinas, Westlake Village CA 91361.



Vector Graphic's Dual-Stor.

One-Hand-Typing Keyboards

Computing is a simple, one-handed task with the Writehander keyboards. Available for either right or left hand, these small new keyboards provide characters for computers, terminals, displays and other 128-character ASCII- or ISO-coded devices. The new model features snap-action switches, improved circuitry and keypressed signals as well as strobe pulses to signal that data is available.

The Writehander keys are mounted on a rugged five-inch diameter hemisphere that conveniently accommodates the human hand. The shape and key locations have been designed so that the fingers and thumb naturally fall on the appropriate switches.

The small keyboard is finding wide application for touch typing and data entry where a free hand is needed, such as for telephone orders, computer programming and for astronomy and microscope observations. Pencil notes may be written with one hand while typing data with the other.

The keyboard code is easily learned by blind people and those with a disabled hand. When connected to portable equipment, the Writehander allows inventory or field survey data to be conveniently entered with one hand.

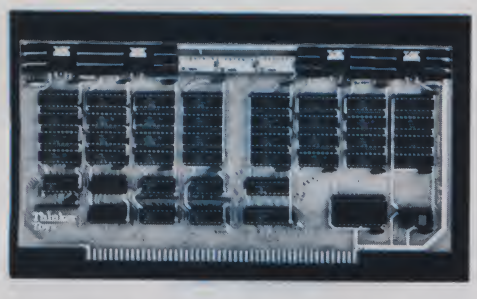
The Writehander can be interfaced with any computer, terminal, printer or other device that will accept parallel 7-bit code signals and provide the nominal power required.

NewO Company, 246 Walter Hays Drive, Palo Alto CA 94303.

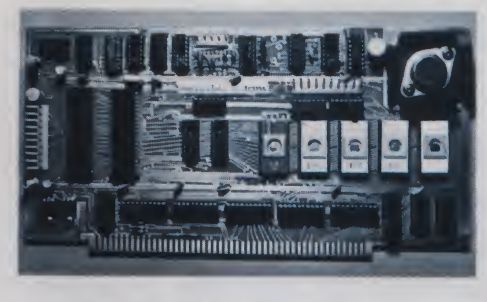
OSI Introduces Single-Board Concept

Ohio Scientific has just developed the world's first complete computer system on a board incorporating a standard computer keyboard, fast microcomputer, video display interface with graphics, audio cassette, 8K BASIC-in-ROM, up to 8K of RAM and power supply on a single printed circuit board.

This single-board concept, made possible by Ohio Scien-



Morrow's new 16K static memory board.



Microdasys' MD-690A CPU board.

tific's six proprietary custom LSI circuits, drastically reduces the parts count and complexity, as well as the price, of personal computers. The new single-board concept will be used in OSI's Super Board 2, which will be a complete computer minus case and power transformer, and in the 600P, which is a fully packaged personal computer system.

Projected prices are $225 to $279 for the Super Board 2 and $329 to $379 for the 600P. Both models are in pilot production now and will be available in the fall of 1978.

Ohio Scientific, 1333 S. Chillicothe Rd., Aurora OH 44202.

CP/M for Micropolis and North Star

Now Micropolis and North Star Disk users can join the software bus. Without any hardware changes, CP/M can be run with all the features available to the users of the two systems on standard floppy disks. These features include dynamic allocation of diskette storage, relocatability of system in memory, intrinsic commands to save, rename, erase and display directories of files and complementary context editor, assembler and dynamic debugging program.

The software package for either Micropolis or North Star includes: CP/M (Version 1.4), $145; Microsoft FORTRAN-80, $400; Microsoft Disk Extended BASIC, $300; CBASIC Compiler/Interpreter BASIC, $95; MAC Macro Assembler, $100; SID Symbolic Instruction Debugger, $85; BASIC-E Compiler/Interpreter BASIC, $30.

Lifeboat Associates, 164 West 83rd St., New York NY 10024.

SuperRam 16

George Morrow, designer of the ECONORAM 4K static memory, has introduced a new 16K static memory board for S-100 microcomputer systems, SuperRam 16.

SuperRam 16 is a complete kit featuring four independently addressable and write-protectable 4K blocks. The design uses just 11 ICs to keep the board uncrowded and trouble-free. The board was designed to meet the proposed IEEE Standard for the S-100, ensuring full compatibility with all S-100 systems. All signals are fully buffered, including address and data lines. Morrow's 16K static RAM retails for $299.

Thinker Toys, 1201-10th St., Berkeley CA 94710.

S-100-Compatible 6802/09

Added features of the MD-690A CPU board over the capability of the MD-690 include: 6809 compatibility, 10K PROM space and RS-232 interface provision. The new MD-690A combines the computing power and software compatibility of the 6802 processor with the hardware compatibility and widespread support of the S-100 bus. This processor has internal 16-bit arithmetic, 8×8 multiplication, 18 addressing modes (the 6800 has six) and five times the throughput of the 6800 (making it three times faster than a 4 MHz Z-80).

The MD-690A comes complete with MONBUG, a 1K PROM monitor program which is software compatible with the standard Motorola MIKBUG monitor; however, it is designed to interface with most memory-mapped video and graphics cards for ultrafast I/O. The board can accommodate up to 10K of 2716 EPROM, which may be used for 8K BASIC or other firmware.

The processor card also features an on-card 2400 baud Manchester cassette interface, interrupt-driven keyboard input for fast I/O and provision for an RS-232 interface. It provides you with 16 I/O ports and DMA capability; there is 1K RAM. The board is high quality, double-sided, plated through, solder masked and silk-screened.

The suggested retail price for the S-100 bus/MC6802/09 CPU board, complete with the 2400 baud cassette interface, 1K monitor and 1K RAM, is $198 in kit form, or $258 assembled and tested. Complete documentation, including assembly and troubleshooting instructions, and a comprehensive user's guide are provided.

Microdasys, PO Box 36051, Los Angeles CA 90036.

ECT Mainframes and CPU Board

Electronic Control Technology's 10-slot Table Top Mainframes are of sturdy construction (similar to ECT's industrial ECT-100 19-inch rack mount card cages). The TT-10 Table Top Mainframe consists of an industrial quality card cage; the MB-10, an S-100 bus motherboard with bus termination and ground plane to reduce noise; a full set of 10 connectors and guides; a 15 A at 8 V, 1.5 A at +16 V and 1.5 A at −16 V power supply, which mounts inside the card cage; a clear satin finished front/bottom plate with a reset switch and power indicator LED; a whisper fan and a vented textured blue cover. Assembled, the mainframe sells for $395; the kit costs $325.

ECT also announces its 8080 CPU, an S-100 bus 8-bit processor board based on the 8080A microprocessor IC. The clock is crystal controlled and digitally generated for optimum system performance. 74LS244 bus drivers are utilized to provide low power with higher drive capability. M WRITE is generated on the board and a switch-selectable 'JUMP' on Reset circuit is provided for use in systems without a front panel. Low-profile sockets are provided for all ICs. The board has solder mask, silk-screened legend and gold-over-nickel plated fingers. Kit, $120; assembled $175.

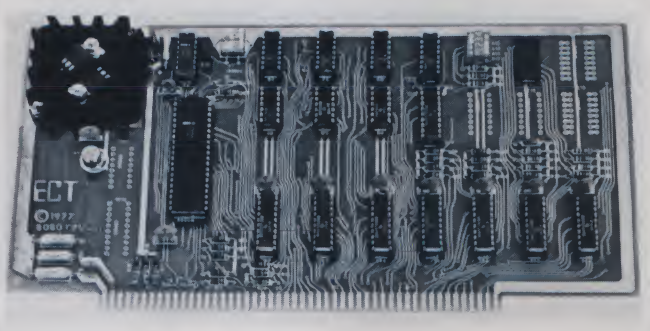
Electronic Control Technology, 763 Ramsey Ave., Hillside NJ 07205.

UMB Universal Printed Board

Looking for a truly universal printed circuit board? Whether you're a design engineer evaluating a new circuit or a representative of a company that manufactures custom and specialty systems, the UMB Universal Printed Board is for you.

Other universal boards do not accommodate both analog and digital components on one board without time-consuming wire-wrapping or other modification . . . whether you're working with microprocessors or other dual in-line packages. UMB is a practical solution to many breadboarding and production problems. Its unique, two-sided interlacing foil pattern incorporates four independent power planes, each one bused to all 264 pad positions.

This design allows you to use both analog and digital components on one board. For example, in mixed analog/digital circuits, one side of the board provides zero and +5 volt distributions, and the other side of the board provides −15 and +15 volt dis-



8080 CPU board with "JUMP" on Reset.

BOOKS ... ADDICTIVE?



SYBEX C-Books are leading University and Industry textbooks, used worldwide, and now translated into most major languages.
They are the result of years of experience in actual education, and have consistently been qualified as 'best pedagogic text ever used'.

"Well planned and executed text (C201)...a complete treatment...self-contained and self-defined...The chapter on 'Internal Operation of a Microprocessor' is the best explanation we have thus far seen in print." (Elementary Electronics, Sept. 78)

WARNING: Readers have Determined that C-series Books May be Addictive. Please let us Know.

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How to interface a microprocessor to the external world, including all common peripherals: dynamic memory, keyboard, LED, floppy disk, CRT display, cassette.
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Esmark's new video integrated electronic tracking pen.

tributions. This arrangement presents low characteristic impedances to the power supply system and, for most applications, minimizes crosstalk between the analog and digital distributions.

Two aspects of the UMB make it especially suitable for prototyping and evaluating microprocessor or interface circuits: (1) the grid of 792 holes available for components are aligned on .100 inch centers in both X and Y axes, (2) none of the component pads are tied to any of the power planes; power planes are bused beside every pad position and require only short jumper wires to make a connection. Dual in-line packages as large as 66 pins may be accommodated on the UMB, and smaller dual in-line packages may be positioned in a variety of configurations to suit the requirement of a circuit or system.

The UMB's construction allows soldered circuits to be changed without destroying plated pad areas. Hole diameters are .043 inch, large enough for almost any component, and all holes are plated-through. Positions for board isolation capacitors are provided near the power entry points. The board measures 4.5×4.0 inches. Price is $15.15 each.

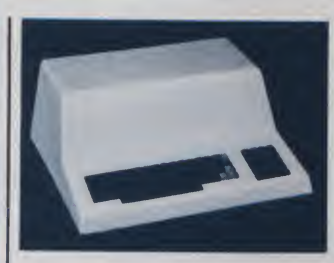
Midgard Electronics, 175 California St., Newton MA 02158.

Vidiet-Stik

Vidiet-Stik, a light-pen compatible with virtually all mini/microcomputer systems, has recently been developed by Esmark, Inc., 507½ E. McKinley Hwy., Mishawaka IN 46544.

Vidiet-Stik (video integrated electronic tracking) can be used for: keyboard substitution with real-time redefinition of key positions; interactive games; educational drills for preschoolers; menu selection; joystick substitution; electronic music keyboard replacement. The package includes the assembled and tested pen, complete computer interface instructions, operating documentation, as well as checkout and game software listings.

Vidiet-Stik software is compatible with all 8080- and Z-80-based systems; it is easily adapted to all other mini and microcomputer systems. The pen's hardware interface requires only three electrical connections: +5 V, ground and a single TTL level signal to any parallel input port. The pen's control software is relocatable to any address and occupies less than 1K of contiguous memory. The Vidiet-Stik is available for $39.95 (plus $1.50 for postage and handling); allow 4-6 weeks for delivery.



TPC's Model 101 case.

Enclosures for Home-Built Microcomputers

Want to add the "professional" touch to your home-built computer? Now you can with the new line of enclosures for home-built microcomputers and terminals from Technical Products Co., PO Box 12983, Gainesville FL 32604.

Constructed of molded fiberglass, the case measures 20×18×8 inches and can support a video monitor or portable TV on top. The keyboard area (20×6 inches) can accommodate both a full-size keyboard and a hex-pad (not included with case).

The case is finished with textured polyester resin and is available in beige, white or black. Cutouts (not provided) are easily made with an ordinary saber saw. Cast-in brackets are provided for mounting to a base. The price of the case is $59.95. A matching fiberglass clamshell-type base (one inch deep) is available for $12.95. Matching expansion modules for peripheral devices will be available in the near future.

Two-Part Computer Music

"Americana Plus" music software is now available for use with the Model 6 and Model 68 Music Boards, Newtech's S-100 bus and SWTP-compatible Music Boards. "Americana Plus" contains more than a dozen precoded tunes, ready to load and run, including five American favorites arranged for two voices. Each voice can have a different sound quality, and two music boards can be used for stereo.

The MD-1NS disk for the North Stark Micro Disk system and the MD-1SW disk for the SWTP MiniFLEX Disk System (both $19.95) also feature "Jukebox," a user interactive BASIC program that permits easy selection of any tune. The MC-1SW cassette ($15.95) for the SWTP AC-30 interface contains the same tunes as the MD-1SW disk. An audio demo cassette with the above songs is also available. Model 6 and Model 68 Music Boards, assembled and tested, are available for $59.95.

Newtech Computer Systems, Inc., 230 Clinton Street, Brooklyn NY 11201.

Software from Software Industries

You can start and maintain your own mailing list with a general-purpose mailing label program from Software Industries, 902 Pinecrest, Richardson TX 75080. Mailing List operations include: Add, Delete, Search, Sorted List, Modify and Sequential Printout.

You have the option of a Remark Field up to 64 characters long for any additional information, which can then be used to sort or retrieve information. You can also set up and change default printing formats controlling the exact placement of up to five labels across a page, whether or not to print the Remark Field and the placement of the zip code.

The program is designed to be easily used without any prior knowledge of computers. Written in Disk BASIC for a Poly-Morphic Systems 8810 or 8813, it comes complete on diskette or as a hard-copy list for $40.

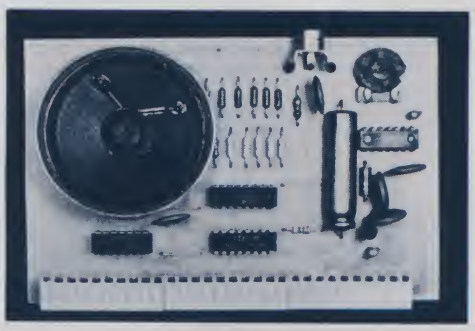
Supersoft Software

Supersoft, PO Box 1628, Champaign IL 61820, introduces two new software packages for North Star Disk. These packs are part of Supersoft's line of 'LOAD AND GO' software.

The Investment Pack contains many programs covering the full range of investments, including options analysis, bond analysis, intrinsic value of stock (Molodovsky method), a complete portfolio management system, as well as a two part macro-analysis system. Several programs are disk interactive.

The Family Pack is Supersoft's answer to the gap between hobbyist software and the strictly business programs. The Family Pack is aimed at the home and is full of programs that range from family/home budget analysis to full-fledged mail and phone lists, as well as tutorials in math and spelling and a simple method of writing perfect letters.

The Investment Pack and Family Pack are $25 each.



Newtech's Model 68 Music Board.



SI's Mailing List program

COSMAC VIP

$249* gets the entire family into creating video games, graphics and control functions. For starters.



COSMAC VIP, the completely assembled, ready-to-operate RCA Video Interface Processor, opens up a whole new world of computer excitement. New challenges in graphics, games and control functions. Yet it's just $249.00.

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Built around an RCA COSMAC microprocessor, the VIP is a complete computer system that can grow with you. It has 2K of RAM, expandable on-board to 4K. Plus a ROM monitor, audio tone output to a built-in speaker, power supply, and 8-bit input and output ports for control of relays, sensors, or other peripherals.

Soon RCA will offer options for color graphics and 256 tone sound generation. An optional auxiliary keyboard will open up an exciting world of two-*player* games.

Take the first step now.

Check your local computer store or electronics distributor for the VIP. Or contact RCA VIP Marketing, New Holland Avenue, Lancaster, PA 17604. Phone (717) 291-5848.

*Suggested retail price. Does not include video monitor or cassette recorder.

The fun way into computers.

RCA

LEGAL/ BUSINESS FORUM

Kenneth S. Widelitz
Attorney-at-Law

In the first Kilobaud *Legal/ Business Forum I speculated on the possibility of federal regulation of microcomputers. In a very real sense, it is no longer speculation. Congress is now considering the enactment of a bill that would regulate the use of microcomputers with respect to automated telephone solicitation. Of course, the bill is not aimed specifically at microcomputers, but rather at the regulation of unsolicited telephone calls. But remember it is microprocessor technology that has raised the problem.*

Jon Roland of the Micro Mart, 1015 Navarro, San Antonio TX 78025, and I discussed this problem at a recent trade show. The following article was written by Jon and directly addresses the problems of computer-generated "junk phone calls."

An increasing volume of unsolicited telephone calls, sometimes made or assisted by small-computer systems, has resulted in a demand for federal regulation. This article will discuss the ways in which microcomputers may be used in this application, the legislation that has been proposed to regulate it and the possible impacts of such use and regulation.

Junk Phone Calls and Micros

Microcomputers are being used now to select or generate telephone numbers and to dial the calls. In some applications, a human solicitor does the talking and records the result. A computer may then be used to process the results of the calls and make appropriate reports. In a few cases, the call consists of a prerecorded announcement, which may invite the person being called to respond by calling back or by remaining on the line after the announcement is complete for a human solicitor to receive the response.

In the future, microcomputers might make possible the issuance of specific, personalized synthetic vocal announcements and the handling of responses by touch-tone or speech recognition, thus totally eliminating the human solicitor except perhaps for exceptional cases.

Telephone soliciting is cost-effective only for certain kinds of products, services and markets, and depends for its effectiveness on being able to obtain a call list of especially good prospects. An example of a common application is the sale of newspaper and magazine subscriptions to persons who have recently moved into the area. It is often more effective than direct mail or broadcast advertising because the caller is in a position to take an order at the moment, just after the announcement is delivered, when the prospect is most likely to respond favorably. This psychological factor, combined with more effective ways of obtaining good lists and the increasing cost of direct mail compared to telephone costs, has made telephone soliciting increasingly popular with merchandisers. The microcomputer makes possible the reduction of the last remaining major cost: the personnel.

Most persons don't mind an occasional unsolicited call, but as the method becomes more popular, the volume of calls has become a source of irritation to many people, especially those calls using a prerecorded announcement. The result has been increasing demands for regulation of the activity.

Garbage In— Garbage Out (Maybe)

The Telephone Privacy ("Junk Call") Act of 1978, S2193, by Wendell Anderson (D., MN) and Thomas J. McIntyre (D., NH), and HR9505 by Les Aspin (D., WI) constitute the legislation that is under consideration, at this writing, before the appropriate Senate and House committees. It would prohibit unsolicited calls to persons who indicate they don't wish to receive them.

Telephone companies would be required to furnish a current list of parties who do not wish to receive unsolicited calls. They would be prohibited from charging customers for being placed on the list. The penalty for making an unsolicited call to a number on the list would be $1000 or 30 days in jail. The FCC would provide specific regulations for implementing the statute. Most telephone systems in the United States would be covered.

Also under consideration is an Omnibus Communications Act of 1978, and it is likely that the Junk Call Act would be incorporated into the Omnibus Act before being sent to the floor of each house. Because of the long lead time between the writing of this article and its appearance in print, readers need to contact their representatives in Congress for the current status of the bill and it contents.

One difficulty with this proposed act as presently written is that it calls for the list to be of "names and numbers" rather than just numbers. This would require persons with nonpublished numbers who wished not to receive unsolicited calls to reveal their numbers to avoid them, since automatic dialing devices could be used to call nonpublished numbers, either by calling all numbers in sequence or by random number calling, as used for polling. If the bill provided for only a list of numbers, without names being revealed, and prohibited unsolicited calls to all nonpublished numbers, this difficulty might be avoided. An impact of this on telephone solicitation would be to effectively rule out calls to new listings not yet made available by the telephone company.

One way to implement such a list would have an asterisk placed beside the name of each party in the directory who wished not to receive unsolicited calls. A problem with this is that directories are usually published only once a year.

As this article is prepared, nothing in this proposed act or any other before Congress addresses the mechanism by which unsolicited calls might be made, and nothing has yet been seriously proposed to regulate the use of automatic dialing or calling devices as such. The number of such devices presently available or in use is still small, and they have not been found useful for sequential dialing of all numbers, both listed and unlisted, for most kinds of merchandising.

The only major use so far for automatic dialing that is not restricted to published numbers has been polling, for which numbers are selected at random. Such dialing could, of course, be restricted to published numbers if microcomputer systems were used to control it. At this time the feeling on Capitol Hill is that to try to regulate the equipment is a solution in search of a problem.

Another difficulty with the proposed act is the definition of "unsolicited." Most people might have what they think is fairly good idea of what kinds of calls they might find objectionable, but not all these ideas are the same, and few of them are easy to put into clear, unequivocal language. Does a person solicit a call if he circles a number on a reader service card in a trade publication? Could a guy wind up in jail for calling a girl for a date at her parents' home when the parents are on the list? Does a person who initiates an inquiry and reveals his telephone number implicitly solicit a telephone reply? This problem of definition is the main rock that may sink the proposed act.

Could the Act Affect the Micro Industry

Neither the problem nor the proposed regulation to solve it is likely to have an adverse impact on the microcomputer industry. On the contrary, it offers an enormous opportunity. Microcomputers are not yet extensively used for telephone soliciting or polling. Most automatic dialing devices are not microcomputer-controlled at this time. Any regulation of unsolicited calls would create a severe need for microcomputers by telephone soliciting operations, most of which are not yet aware of microcomputers or sufficiently sophisticated to make use of them. If the proposed act is passed, they will become almost essential to any such operation. They will be required to reliably check numbers against the list of prohibited numbers to insure that calls to those numbers are not placed.

The proposed act, however, is not a satisfactory solution to the problem of privacy. It is likely to create more problems than it would solve. Many on Capitol Hill understand this, and passage of the bill, as written, during this session is doubtful.

How It Might Work

The real solution to the problem is to make use of microcomputer technology to make available to telephone customers a low-cost terminal (what other people call "receivers") that could screen calls. This would be facilitated by having the number of the originating terminal or the name or access code of the caller transmitted to the receiving terminal, which could screen the call by reference to a lookup table and decide whether to accept or reject the call. This could easily be done now for local calls by use of a microcomputer device attached to an ordinary telephone receiver.

The answering device would announce to the caller that for the call to be put through, he would have to supply the appropriate access code, by dialing or touch-tone, and if the proper code were given, the telephone would ring (or forward the call or take a message). This would not work for long-distance calls if long-distance charges were to be avoided for rejected calls, but the reciever might not care about saving the money of nonaccepted callers.

Present telephone tariffs and court decisions make it easy to implement such a device for use by telephone customers, and if the cost can be made low enough, it is likely that there might be a great many customers for such an addition to telephones, especially if combined with other useful features.

Unfortunately, at this point it would be expensive to convert the telephone system to the automatic transmission of the number of the originating terminal and an access code to the receiving terminal, but this is clearly a feature that needs to be incorporated in the future. Legislation might be needed to encourage this and other needed improvements in the telephone network to make it ready for the coming generation of multipurpose terminals that will replace the telephone receiver and most office machines, as well as provide stand-alone computing power to everyone.

Another needed improvement in the telephone system is conversion to pulse-code modulation, and the transmission of all signals digitally. Analog transmission is wasteful of channel capacity. Low-cost PCM communication service would make feasible such needed amenities as electronic mail and electronic funds transfer, and lower the cost of terminal equipment. The use of real-time trapdoor coding would provide every person with reliable, private, secure communications of every kind and usher in a new age of communication, information processing and societal management. Wiretapping, even by the telephone company, would be a thing of the past, except to monitor signal quality and prepare bills, since the coding would be under the control of the customer-owned terminal.

A Look to the Future

At this time, the need to make an orderly transition from the present system of voice terminals to high-bandwidth multipurpose terminals is not well understood on Capitol Hill or adequately anticipated in the presently proposed Omnibus Communications Act or related legislation that would impact on this subject. There is a need for those of us who can anticipate the needs to make constructive inputs to the legislative process.

Some things need to be said about the legislative process at this point in our history. It is being said on Capitol Hill that "it's not as much fun up here anymore." The Voice of the People is becoming increasingly strident, demanding, uncompromising, discourteous and nonconstructive.

More than ever before, our elected officials are facing problems that are not well understood by anyone and for which there are no easy solutions that anyone can readily agree on. People are making demands that are impossible and not understanding why those demands aren't being met instantly. What we need now is less heat and more light. The readers of this magazine, as a group, tend to be more patient and positive in their dealing with complex problems, but need to do more to help solve the problems of the world.

THE BASIC FORUM

John Arnold/Dick Whipple

Judging from the response we are getting to our programming problems, readers are anxious to put their computers into action. This is especially gratifying because it indicates that there are still people out there who like to charge their mental "batteries" by solving challenging problems. We plan to keep up a steady flow of new problems so long as you stay interested. By the way, if you know of a programming problem that would be appropriate, send it along and we will try to use it in a future column.

Before presenting the results of the April problem, we have a few letters to put before the Forum. We are occasionally called on to defend the use of BASIC, especially by beginning programmers. (See the April column, for instance.)

Not Just for Beginners

Apparently in the eyes of one reader we have not been strong enough when stating our position. Viron E. Payne, 200 Juniper Ave., Merritt FL 32952, writes:

"Now just wait one minute. You guys did a fine job in the April issue of defending BASIC from the standpoint of the beginner, but that is really condemning by faint praise. You let pass D. A. Harrod's remark that he uses a FORTRAN with a Double Complex Hyperbolic Tangent function without bothering to ask just who needs such a function. I am a semi-retired electronic engineer, and I have never needed one. I also spent my time programming in an engineering environment for several years, and now do varied types of programming.

"I started programming on an IBM 602A Electromechanical Calculating Card Punch, plugboard-programmed yet . . . then to a 607 electronic machine (would you believe vacuum tubes), also plugboard-programmed. During this time I programmed on an IBM 650 in a symbolic language called SOAP (Symbolic Optimum Assembly Program). Next came FORTRAN programming on the IBM 7000 series, followed by a few years' programming an IBM 1620 in a symbolic language, SPS, in FORTRAN and in machine language. I also used a FORTRAN dialect called FORCOM.

"A few years out of programming, I started using a time-sharing system having two Honeywell 6000 (old GE 635) processors hooked together and operating as one big computer. It had FORTRAN, BASIC, COBOL and a few other languages available. When I got on the system I received handbooks on the various languages. That was my first look at BASIC. After looking it over, despite my former experience with FORTRAN, I saw that I could program anything I would ever need to do in BASIC, and do it much more quickly, so I made the switch. I did write a few programs in the time-sharing version of FORTRAN IV, but these only served to convince me more that BASIC was the language to use.

"After two years on this system I purchased an Altair 8800A in kit form and let my 16-year old son assemble it for me. I got 4K of memory and 4K BASIC and played with it long enough to convince me that I had a real computer, not a toy, and then got 24K more of memory and both 8K and 12K BASIC, all Altair Version 3.2, paper tape. I used the ASR-33 TTY I had used on Fulton Data Systems' time-sharing system. I am pleased with what I have and would not put FORTRAN in my machine if someone gave *it to me. My* programs do not use that DCHT function, but neither are they trivial.

"Much of my computer's time is spent predicting the future course of the stock market. To do this I make a Fourier analysis of the past price action to determine the cycles present in the data and then project these into the future. Each point in a prediction involves the sum of 30 or more trigonometric functions, and the delay between printing lines is only about two seconds. If the TTY had a one line buffer there would be no delay at all. I also do a lot of word handling, including large alphabetic sorts. Using my own improvement of the Shell sort algorithm, these run

fairly rapidly.

"I can usually sit down and write a new program and have it running before I would be able to write the FORMAT, EQUIVALENCE and COMMON statements of a FORTRAN program. I must have hard copy from formed letters, not a matrix, as my output must be used as offset masters after being reduced half size. Therefore, I am stuck with the TTY and am usually I/O bound. Increased speed would help me little, if at all.

"Incidentally, the Altair BASIC is far more powerful than that on the time-sharing system. Of course, the system had a wonderful operating system and unlimited disk storage, which was nice, but their BASIC was positively primitive compared to Altair's. I use the 8K BASIC almost exclusively to conserve memory space, and find it far better than that on Fulton Data Systems. I have also compared it to various microprocessor BASICs and found it superior.

"For example, North Star BASIC would be unusable in my word-processing work. Its subscripted string table capability is a farce. I must have multidimensional string table capability without wasting memory by filling in short strings with blanks to the length of the longest strings. The built-in Mini-Max function is of great help in automatically selecting the proper scale values for plots of future stock-market movements. Truly, the software *is* the computer, and Altair BASIC makes a fine computer.

"This has been a long letter, but I hope it has convinced you boys that BASIC is not just for beginners—if you have a good BASIC. I recently read that a large time-sharing system has been set up in Japan, used jointly by three of the largest universities. The primary language on the system is an expanded BASIC. I have an idea that much of the opposition to BASIC comes from programmers who are afraid that BASIC will make programmers so common that their livelihood will be in danger. Now let's see you defend BASIC for what it really is: a very good programming language, simple enough for beginners to play with, but capable enough, in the hands of an expert, to do anything any of the other languages will do."

BASIC—Here to Stay

Mr. Payne is certainly a satisfied BASIC user. He represents the group who somehow wind up using (and liking) BASIC after years of working with other languages. There are others, however, who "cut their teeth" on BASIC and then move on to more exotic languages. A member of this latter group is Joseph D. Shapiro, 1654 Feuereisen Ave., Bohemia NY 11716. Consider these comments of a "former" BASIC user.

"First, I learned programming in BASIC on a DEC PDP-10, but if my colleagues caught me writing a BASIC program now, I might find myself institutionalized.

"I want to take this opportunity to make a few statements about BASIC.

"Second, for bad programmers, BASIC provides an excellent medium for writing kludges; this is probably the root of the dim outlook most professionals have for BASIC. But more important, BASIC provides a medium for bad programmers to become good programmers, and good programmers to write a good code. Furthermore, it is publications like *Kilobaud*, and columns like yours, that give beginners the incentive to try new, challenging problems, leading to better techniques. Keep up the good work."

We think the arguments for and against BASIC will rage for years to come. In our opinion, the wide acceptance of BASIC among micro-users has made most of the haggling back and forth rather academic anyway. BASIC is here to stay.

Special Function Keys Needed

We recently had occasion to use a Wang minicomputer and one of the new IBM 5110s. One of the features of these systems (and some other commercial units) is a set of special function keys on the keyboard. Generally, these keys can be programmed to link directly to a BASIC subroutine resident in memory. When a key is struck, branching occurs to the subroutine where a special processing task is performed. The keys can even be used while sitting in an INPUT statement of another program. Thus, you can make special calculations while entering data. Bob Lurie, 8 Twigley Rd., Morristown NJ 07960, has missed this feature on the current crop of micros. He writes:

"Does there exist a BASIC interpreter or compiler that permits the user to *conveniently* do scratchpad calculations prior to INPUTting a number during the execution of a program, or that permits entering a numeric expression (i.e., 3*SQR(2)) rather than just a number? Even the simplest of the now widely available programmable calculators gives the user access to a so-called scratchpad, and one of my most serious gripes about all of the BASICs I've seen is that they lack this—to my way of thinking—elementary and essential capability. It just doesn't seem right that one should require a pocket calculator at his side when sitting down in front of a $2000 computer!

"The enclosed BASIC utility program (Program 1) for scratchpad (direct-mode) access was written in Processor Technology's new extended BASIC (almost 16K long, and 15 months overdue, but still without extended precision or string arrays!). In the program I am writing, I no longer use the INPUT command at all for numeric variables (except as it appears in the subroutine in lines 1000-1120). All calls for user input now follow the format of line 40.

"Pretty cumbersome, eh! There ought to be a better way."

Perhaps some of our readers can come up with an implementation of special function keys. Send your suggestions to The BASIC Forum.

Contest Results

Now, the results of the April contest. We received more than 50 entries. Most were well documented and only three were totally incorrect. The problem as stated was to write a BASIC program that will: (1) accept any list of integer numbers of three digits or less (maximum of 100 numbers); then (2) print the entire list as entered; then (3) reprint all elements of the list that appear only once.

First, let us make some general comments.

1. Although we limited the problem to a maximum of 100 numbers, we did expect the program to be general and not written specifically for the 26 values in the sample run.

2. While data entry could be via an INPUT or READ-DATA statements, we expected the full list to be printed *after* data entry was complete. This served to verify that correct numbers were placed in the list.

3. In (3) above, there was a slight ambiguity. We quote from a letter by Dave Leestma:

"In (1) you refer to integer *numbers* of three digits or less, but in (3) you ask to reprint all *elements* of the list. If *numbers* is the requirement, then leading zeros or embedded blanks will be ignored in determining a dupli-

```
  10 REM...SCRATCHPAD UTILITY SUBROUTINE FOR PTCO EXTENDED BASIC
  20 REM...EXAMPLE
  30 DIM A$(16),R$(14)
  40 LET A$="ENTER V2(1):  ":GOSUB 1000:LET V2(1)=A
  50 PRINT   V2(1)=";V2(1)
  60 END
1000 REM...THE SUBROUTINE
1010 PRINT A$;:INPUT"",R$:REM..."SURPRESSES ?
1020 REM...HIT CARRIAGE RETURN FOR ACCESS TO SCRATCHPAD:
1030 IF LEN(R$)=0 THEN 1080
1040 REM...CHECK FOR NUMERIC INPUT:   (NOT FOOLPROOF)
1050 LET A=ASC(R$)
1060 IF A=43 OR A=45 OR A=46 OR (A>47 AND A<58) THEN LET A=VAL(R$):RETURN
1070 GOTO 1010
1080 STOP:REM...NOW IN DIRECT MODE
1090 REM...TO RESUME PROGRAM EXECUTION TYPE (1) "A=XXXXXXXX" CR
1100 REM...(2) "CONT" CR
1110 REM...(XXXXXXXX MAY BE A NUMBER OR A NUMERIC EXPRESSION)
1120 RETURN
RUN

ENTER V2(1): -.125
   V2(1)=-.125

READY
RUN

ENTER V2(1):
STOP IN LINE 1080
PRINT 47/.91
 51.648351

A=47/.91
CONT
   V2(1)= 51.648351

READY
RUN

ENTER V2(1):

STOP IN LINE 1080

A=SQR(2)
CONT
   V2(1)=1.4142136

READY
```

Program 1.

```
 10 REM KILOBAUD PROBLEM: APRIL 1978
 15 REM AUTHORS: NANCY SCHWARTZ AND CAROL ASCOLILLO
 20 DIM N(100)
 30 FOR J=1 TO 100
 40 READ N(J)
 50 IF N(J)=9999 THEN 75
 60 PRINT N(J);
 70 NEXT J
 75 PRINT
 76 PRINT
 80 FOR K=1 TO J-1
100 FOR L=1 TO J-1
110 IF K=L THEN 140
120 IF N(K)=N(L) THEN 160
140 NEXT L
150 PRINT N(K);
160 NEXT K
900 DATA 6,-10,15,7,7,7,6,-8,7,2,150,-6,13,12,12,5,-5
910 DATA 19,18,19,18,19,105,421,31,5,9999
999 END
RUN

6 -10 15 7 7 7 6 -8 7 2 150 -6 13 12 12 5 -5 19 18 19
18 19 105 421 31 5

-10 15 -8 2 150 -6 13 -5 105 421 31
```

Program 2.

```
 10 REM KILOBAUD PROBLEM: APRIL 1978
 15 REM AUTHORS: NANCY SCHWARTZ AND CAROL ASCOLILLO
 20 DIM N(100)
 30 GOSUB 200
 40 GOSUB 300
 50 GOTO 999
200 REM SUBROUTINE #1:READ AND PRINT DATA LIST
210 FOR J=1 TO 100
220 READ N(J)
230 IF N(J)=9999 THEN 260
240 PRINT N(J);
250 NEXT J
260 PRINT
270 PRINT
280 RETURN
300 REM SUBROUTINE #2:PRINT NON-DUPLICATED NUMBERS
310 FOR K=1 TO J-1
320 FOR L=1 TO J-1
330 IF K=L THEN 350
340 IF N(K)=N(L) THEN 370
350 NEXT L
360 PRINT N(K);
370 NEXT K
380 RETURN
900 DATA 6,-10,15,7,7,7,6,-8,7,2,150,-6,13,12,12,5,-5
910 DATA 19,18,19,18,19,105,421,31,5,9999
999 END
```

Program 3.

cate. If *elements* is the requirement then items must be character-by-character identical in order to be duplicates."

Good point, Dave. We meant numbers in both (1) and (3). If elements were correct, it would suggest the use of strings to store the data. Some entries (including Dave's) used this technique. See Bob Lurie's letter below.

4. We were not specific enough concerning how entrants should give the size of their programs. Several stated their program's size in bytes of memory, which is fine, but most did not. In the future, we ask that program size be specified in bytes (8 bit) and include memory used for variable and string storage.

These points made, let's look at a few solutions. The first is no doubt the simplest and most concise. It was submitted jointly by Nancy Schwartz, 16 Morse Circle, Northboro MA 01532, and Carol Ascolillo, 14 Morse Circle, Northboro MA 01532.

"Enclosed are two solutions to the problem presented in the April 1978 issue of *Kilobaud*. These were developed on a 12K Altair 8800 utilizing Mits 8K BASIC. The solution is presented in two different forms: (1) direct approach using nested "For To Loops" (Program 2); (2) structured programming (Program 3). We hope this will satisfy your publication needs."

All elements of array N are compared to all other elements of the same array. The PRINT statement is skipped if a duplicate is found (other than an element compared with itself). Note there is some wasted effort in that each pair of elements is compared twice. Execution time could be improved, but memory efficiency is quite good.

Many entries were quite elaborate, both in algorithm and documentation. Kenneth Graham's, 182 Briarwood Dr. East, Berkeley Heights NJ 07922, was a representative example.

"Attached is a solution (Program 4) to your 'Casting Out Duplicates' problem. It was run on The Service Bureau Company's CALL/370 time-sharing system.

"I have two comments on the instructions: (1) They do not say that the entire list cannot be printed out before further processing, hence I assumed it was merely a formality to verify the list as entered. (2) They do not say that the items that appear only once must be printed in the order in which they appear in the original list entered.

"Thus I used a simple method based on the basic logic of an exchange sort. However, instead of testing for greater than or less than, the program only sorts equal items into adjacent positions at the top. If there is no exchange necessary, the ith item must be unique. By swapping the matching items, all remaining items in the list are potential candidates for being unique elements. If the items were printed in the order they appeared in the original list, the program could

(continued on page 25)

```
100 DIM L(99)
110 N=1
120 INPUT L(N)
130 IF ABS(L(N))>999 THEN 160   !INTEGER OF MORE THAN 3 DIGITS ENDS LIST
140 N=N+1
150 IF N<100 THEN 120           !LIMIT TO FEWER THAN 100 ITEMS
160 N=N-1                       !N IS NUMBER OF ITEMS
170 PRINT"LIST:";
180 FOR I=1 TO N                !ENTIRE LIST PRINTED FIRST
190 PRINT L(I);
200 NEXT I
210 PRINT
220 PRINT"ONLY ONCE:";
230 I=0
240 I=I+1                       !FIRST POINTER IS ITEM TO CHECK FOR MATCH
250 T=9999                      !DUMMY ITEM
260 IF I>N THEN 390
270 J=I                         !SCAN LIST BELOW FIRST POINTER
280 J=J+1
290 IF J>N THEN 360             !END OF LIST?
300 IF L(J)<>L(I) THEN 280      !IF ITEMS DO NOT MATCH KEEP SCANNING
310 T=L(J)                      !PUT MATCHING ITEMS TOGETHER AT TOP
320 L(J)=L(I+1)
330 L(I+1)=T
340 I=I+1                       !MOVE FIRST POINTER DOWN ONE
350 GOTO 280                    !KEEP SCANNING TO GET ALL MATCHES
360 IF T<>9999 THEN 240         !DID WE SWAP ANY ITEMS
370 PRINT L(I);                 !IF NOT,PRINT ITEM APPEARING ONCE
380 GOTO 240                    !CONTINUE THROUGH LIST
390 END
RUN
?6,-10,15,7,7,7,6,-8,7,2,150,-6,13
?12,12,5,-5,19,18,19,18,19,105,421,31,5
?9999

LIST 6 -10 15 7 7 7 6 -8 7 2 150 -6 13 12 12 5 -5 19 18 19 18 19 105
421 31 5

ONLY ONCE: 15 -8 -10 2 150 -6 13 105 4 21 31 -5
```

Program 4.

```
 10 REM...>=2=0...REV A
 20 REM...A PROGRAM THAT CASTS OUT ELEMENTS THAT ARE DUPLICATED
 30 REM...(USES MINIMUM MEMORY-RUNS FAST)
 40 REM...REF: BASIC FORUM  KILOBAUD 4/78
 50 REM...BY: ROBERT J. LURIE  MORRISTOWN, NJ
 60 REM...PTCO EXTENDED CASSETTE BASIC VER A
 70 REM
 80 DIM A$(501),E$(24)
 90 LET S$=CHR(160):REM...THE CHANGE..HOW CLEVER!
100 LET A$=S$
110 INPUT E$
120 IF LEN(E$)<>0 THEN LET A$=A$+E$+S$:GOTO 110
130 PRINT:PRINT A$:PRINT
140 REM
150 REM...HERE'S THE ROUTINE
160 REM
170 LET P=1
180 IF P=LEN(A$) THEN PRINT A$:END
190 SEARCH S$,A$(P+2),P1
200 LET P1=P+P1+1
210 LET E$=A$(P,P1)
220 SEARCH E$,A$(P1),P2
230 IF P2=0 THEN LET P=P1:GOTO 180
240 SEARCH E$,A$(P),P2
250 IF P2=0 THEN 180
260 LET P2=P2+P-1
270 IF P2+LEN(E$)>LEN(A$) THEN LET A$=A$(1,P2):GOTO 240
280 LET A$=A$(1,P2)+A$(P2+LEN(E$)):GOTO 240
RUN

?SUGAR
?AND
?SPICE
?AND
?EVERYTHING
?NICE
?

\SUGAR\AND\SPICE\AND\EVERYTHING\NICE\

\SUGAR\SPICE\EVERYTHING\NICE\

READY
```

Program 5.

BOOKS

Computer Design Development —Principal Papers
Ed. by Earl E. Swartzlander, Jr.
Hayden Book Company, Inc.
Rochelle Park NJ, 1976, $13.95

Nowadays it is hard to imagine anyone getting excited over the prospects of building an "electronic computing instrument" featuring 4000 words of storage, one accumulator, one "shift register" and fewer than 32 instructions. And yet these are the basic specifications for the first real electronic digital computer, as proposed in a June 1946 paper by Burks, Goldstine and von Neumann.

Earl Swartzlander has performed a valuable service for all of us by collecting this and 18 other papers of great significance in the history of the digital computer into a single reference book. He describes his book as a "textbook," but it is also both valuable and interesting reading for everyone from computer hobbyists to computer-science students. The collected papers range from the first description of the flip-flop (Eccles & Jordan, 1919) to the design of the cache memory for the IBM 360 (Liptay, 1968). Papers included in the book cover hardware design, pure mathematics and the mathematics of digital machines.

Just casually browsing through this collection will reveal how old some of our "new" ideas really are. That high-speed wonder of the second half of the 70s, the bit-slice processor, is described in a 1951 paper by M. V. Wilkes. We are also amused by some of the early terms: "storage organ" for main memory, and "order tank" for instruction register. It is also amazing to realize just how far we have come in 25 years, from the time when a proposed memory access time of 50 microseconds produced the comment: "It does not seem possible physically to achieve such a capacity." Or from the time when that 4000 word memory is described as being *ten times* the capacity needed to solve "most problems."

Computer Design Development will probably be required reading for computer-science students, but it is also a gold mine of amazement and amusement for the amateur and/or hobbyist.

Ken Barbier
Borrego Springs CA

Microcomputer Problem Solving Using PASCAL
Kenneth L. Bowles
Springer-Verlag
New York, 1977, $9.80

Dr. Bowles' *PASCAL* is a textbook used in courses taught at the University of California, San Diego. As such, it contains a lot of material specific to UCSD's version of the language, and a lot of material specific to the terminals used on the campus. You might well ask, then, of what value is it to anyone not attending those courses or having access to those terminals.

Speaking for myself, I shelled out the decabuck required in order to evaluate the capabilities of PASCAL, as it is now available for 8080/Z-80 based microcomputers, and my system is almost big enough to accommodate this higher-level language. I had been assuming that the next move up for my system would be from BASIC to FORTRAN IV, which is also now available for micros.

I had previously investigated PL/M and rejected it for reasons I can only describe as "emotional." I simply don't *like* PL/M, regardless of it's capabilities. In order to touch all the bases, I acquired the PASCAL book to see if there is a slight possibility that the language has any future in microcomputing. And does it ever!

This book is more than just a textbook covering UCSD PASCAL. It is worth its price as an introduction to programming, usable even without access to a computer—or as a guide to program structuring. As I used it, the book is a useful tool in evaluating the new language. It also constitutes a source book for ideas to incorporate into a graphics package (not confined to PASCAL).

Any user of a micro or a mini, programming in any language from assembler up, will find much of value in this book. The danger involved in reading it is that the chances are great that the reader will become hooked on PASCAL—which is what one would expect, since it is a new language designed to overcome the weak points of its predecessors. But it is in the presentation of the various topics that the danger really lies.

The reader is led so skillfully into the statements of the problems, the analysis of the programs to solve them and the discussions of other possible methods that the book takes on the flavor of a good mystery story. The reader is led into each topic in such an intriguing manner that he becomes personally involved and can't put the book down until he finds out how it all comes out!

What does come out in the end is the realization that PASCAL, helped along by the skillful presentation in this text, will probably become *the* small-systems language in the near future. Computerists whose only joy is in number crunching will undoubtedly scream out that *no* other language can replace APL. And they are right, for their uses. But for the rest of us, who do accounting, controlling, text editing or what-have-you, Ken Bowles presents a convincing argument that PASCAL is the language we *must* implement on our little machines.

Ken Barbier
Borrego Springs CA

A History of π (Pi), 3rd Ed.
Petr Beckmann
St. Martin's Press, New York
Paperback, 200 pages, $4.95

"The history of pi is a quaint little mirror of the history of man. It is the story of men like Archimedes of Syracuse, whose method of calculating pi defied substantial improvement for 1900 years; and it is also the story of a Cleveland businessman who published a book in 1931 announcing the grand discovery that pi was exactly equal to 256/81. . . ." Thus starts what can only be called a wry and offbeat book.

Petr Beckmann is a firm believer in the need for an understanding of science and mathematics and uses his examination of the history of pi to reveal the foibles of man—pointing out where he can because of his perspective that whenever there has been ignorance and mysticism there has been tyranny over the ignorant and mystified.

The order of the book is, naturally enough, chronological: The Dawn of Man, The Early Greeks, Archimedes of Syracuse, Dusk, Night, Awakening, Newton, Euler. Perhaps the most interesting chapter is the one on Euler, whom Beckmann, with some justification, considers the greatest mathematician who ever lived. One example given is the problem that had baffled mathematicians for centuries: What is the sum of the infinite series

$1/1^2 + 1/2^2 + 1/3^2 + 1/4^2 + \ldots$?

As formidable a mathematician as Leibniz failed to sum it, along with Jacques Bernoulli who could only prove that it did converge to something. Not only did Euler find the solution—shown by Beckmann—but it turned out to be $\pi^2/6$, thus giving a formula for the calculation of pi as fallout!

The later chapters deal with the sad attempts to square the circle, and the digit-hunters who (thanks to Euler's many formulas) calculated pi by hand to more decimal places. Surprisingly, pi had been calculated (correctly!) to 500 places by Richter in 1855.

All of the interesting little goodies about pi you've only heard about come next: the proofs of the irrationality and transcendence of pi, formulas for computation, Buffon's Problem (computing pi with a matchstick and a grid of lines) and a nearly successful attempt by the Indiana State Legislature in 1897 to introduce "a bill for an act introducing a new mathematical truth and offered as a contribution to education."

This amounted to some stupendous goofs in plane geometry by a Mr. Edwin J. Goodman, M.D., who deduced among other things (and kindly offered his findings to the state) that $\pi = 16/\sqrt{3}$, which is about 9.2. Fortunately, a Purdue mathematics professor found out about the bill and coached the legislators. The bill was dropped. From this presumably stem the unconfirmed myths that a state legislature once tried to define $\pi = 3.0$.

The final chapter outlines (too briefly) the history of digital computer computations of pi, which

(continued on page 25)

TROUBLE-SHOOTERS' CORNER

Ralph Wells

How do you troubleshoot a "dead" system? Sooner or later it happens to all of us—the system dies. What to do? In the last few columns we've used this question to explore some fundamentals of troubleshooting, and last month we looked at *substitution* as a means of defining the problem. This month we'll wrap up the basics by going into the theory of *tracing* trouble.

The basic principles of *synergistic synectics, boxing* your problem, *binary search* and *wall moving* are still prerequisites for any type of debugging. Defining the problem is usually the tough part, and fixing it is the easy part.

Think of It as a Brainteaser

Tracing a problem is usually slower than substitution and often requires more equipment and expertise. Though often the choice of the professional who has both, tracing certainly isn't limited to use by the "experts."

If you have a knack for brainteasers, puzzles and problem-solving in general, then tracing will probably be not only effective for you, it will also be fun. It certainly yields a heartwarming sense of accomplishment when the challenge has been met. Some people I know revel in such challenges. Anyone who can "psych" himself into looking at his bugs (including a dead system) as brainteasers will not only find success more quickly but also learn more in the process.

If you'll look back over your own experience, you'll probably find that you learned more from your problem-solving experiences than you did from books or teachers! Of course, it's a lot easier to think of it as a game if *you're* working on a friend's problem and it's not your own system that just bombed out.

Tracer Bullets in Your Ammunition

A microcomputer works much faster than a machine-gun bullet —both work invisibly. If you want to see where a machine gun is aimed, you substitute a tracer bullet every so often. This tracer may not be much of a bullet, but it shows you where the action is —dramatically. The same principle applies to your computer: Substitute something to make the invisible visible.

This basic principle applies to both software and hardware problems. Both can be solved more easily if you have special equipment; however ingenuity and "stick-to-itiveness" can usually compensate for equipment deficiencies.

Moving Walls

Last month I went into the principle of boxing in your problem with walls and then moving the walls together to get a clear definition of what is really wrong. When tracing is combined with expertise or just good common sense, it can usually solve baffling problems faster than the substitution methods discussed last month. Both methods can move the walls, and a good troubleshooter has both bullets in his breech. As with substitution, tracing should be used to set up walls or divide lines between elements of the system that are known to be good and those that are bad or are questionable.

Take It from the Top

The most common way to approach something is to start at the beginning; we've been doing it since childhood. This method has its merits, but the fastest way to find out if the butler did it is to read the last chapter first. Looking at the answers in the back of the book may be unethical, but it solves arithmetic problems, and the principles involved are the basis for tracing techniques that are not only ethical but potent (more on these later).

If we choose the take-it-from-the-top approach to computer problem-solving, then we will start at the beginning of the program (if it's a software problem) or at the input of power or signal (if it's hardware). Let's take the soft side first. After the program is loaded, then hitting RUN or GO will set the program going at the first statement like a conductor's downbeat. It will then proceed as it's "written" until something goes awry.

Our job is to find out where and why it goes awry. You often have clues that tell you some elements of the program are working, so you can set up some walls of the box before you even start. The next object is to close in your walls on the problem in as few steps as possible, using the "game plans" and binary search discussed last month.

An obvious method would be to find some point about halfway through the program and install some indicator, such as a STOP, END, SOFTWARE INTERRUPT, PRINT or JUMP TO ALARM routine. If it didn't get that far before it bombed, then divide the problem in two and set your traps at one-fourth of the way through your program, then at one-eighth and so on, until you find something that works.

A Software Trace

The top-down approach is usually best implemented by using a TRACE program if it's available. A TRACE program allows you to run your program the same way you wrote it—step by step. It usually works directly from machine language, decoding each instruction and displaying it as it is executed. In its higher forms it displays not only the mnemonic op codes, data and address values, but also the contents of the primary registers, and status codes (decoded), the ASCII equivalents of the accumulator and the addresses of branches and jumps.

A really good TRACE will allow easy modification of all registers and memory contents. It will also indicate how many subroutines "deep" you are into the program and give you the option of single-stepping through a subroutine or allowing it to run normally. It should also allow you to start at any point in the program and to run at normal (or near normal) operating speeds until it reaches a predetermined point at which it reverts to single-step.

If you intend to do much assembly-language programming, then you should try to get a trace for your system. I've been using Ed Smith's DISASSEMBLER/TRACE for 6800 development and the built-in monitor trace on my Apple for the 6502. Once you've used a good TRACE program you get spoiled, and it's so hard to do without it that I don't think I'd try doing a long program for any system that couldn't be traced.

One Step at a Time

My first personal computer (Altair 8800) had a rudimentary TRACE function by virtue of its single-step capability and the LEDs on the front panel. It was expanded somewhat by the Imsai 8080 and KIM that followed, but it was still only a single-step function with limited readouts. It was not until I obtained the second version of Smith's TRACE program for my Sphere (from Programma Associates) that this technique for debugging became virtually indispensable.

TRACE isn't anything new—the COBOL used in our big Burroughs 3500 has had a TRACE function for years; however not many personal computerists can afford it.

Disassemble a Bug

If you've been working with a BASIC interpreter, you've probably had no need to investigate the TRACE or its first cousin, the DISASSEMBLER. As soon as you graduate into machine language you'll feel the need—acutely. All TRACE programs have to include most of the functions of a DISASSEMBLER, so it's common practice to throw in this valuable feature in the same package.

As you would expect from its name, the disassembler reverses the process of the assembler that converted the mnemonics of an assembly language into the almost unintelligible (for humans) binary code (object code) used by your computer. A good disassembler will calculate the relative addresses and give you the absolute address. It goes straight through your program and gives you a listing (assuming that you have a CRT or printer) that should correspond very closely to your original program.

Comparing this disassembled listing with your assembly-language program will show up bugs due to errors made in the original coding, as well as assembler errors, save/load errors and hardware errors. The most common

bugs a disassembler reveals in my programs are the syntax errors I make in encoding, in particular, my tendency to mix up absolute values and page 1 addresses, especially in the extended indexing modes of the 6502.

Using a disassembler is similar to proofreading a script. It shows up your *unintentional* errors, but if you didn't know how to spell a word in the first place, it won't call it to your attention. If you have a synergistic relationship with a friend who is also writing for a similar system, then he can often detect your boo-boos from a disassembler check, just as my proofreader picks up my split infinitives in these columns. I make so many errors in my first draft of a program that a disassembly of it will almost always show some of them up. It's a fast check, and unless you have a lot of warranted confidence in your programming skills, it can probably save you a lot of debugging time.

Blazing a Trail

When our forefathers ventured into the unknown wilderness they left their marks behind on trees and rocks to mark their trail. Today the unknowns are different, but the principles behind marking a trail are just as valid. I've already mentioned the use of PRINT statements. "Sprinkling" a BASIC program with PRINTs is one of the easiest ways of marking a microsecond trail that's taken a fatal turn in less than the blink of an eye. Even a PRINT sometimes takes too long, but storing the data in a safe area in memory can still solve the problem.

If you're working in machine language, then tracing a program is more difficult. Most of the older high-level languages (such as COBOL), which are intended to run on big computers, have some sort of trace facility that gives you a printout of the path your program has taken. It means wading through yards of printouts, and you have to do a lot of recompiles—but it works.

Theoretically, you can do the same thing with a micro, so I tried it. It works, but I can't recommend it . . . maybe if you're working with a high-speed assembler and disk, but not for the usual "home" system and not for me; not yet anyway.

Divide and Conquer

There are times when none of the methods I've mentioned are really effective. At these times you should consider "unbundling." There is an old parable which states that even though you may not have the strength to break a bundle of sticks, you can unbundle it and break one stick at a time. This is the technique I use when developing the software for large systems: Tackle one segment at a time, debug it, then take on the one adjacent to it. For shorter programs the top-down (first-things-first) approach determines the order of segments considered, but for the long ones, the most difficult segment is usually tackled first.

When the tough bugs are solved, the remaining problems in the program are usually rather well defined so that debugging by segments becomes the fastest way to success. The dividing lines between segments become the natural points to set up "wall movers" in the final debugging phase.

To the Rear—March

The normal flow for both hardware and software is to start from an input and proceed to an output—the "from-the-top" approach. I've described several methods of using the normal inputs and setting up temporary outputs to trace the trouble. This is the *natural* way we've always solved problems, but it's not always the best.

What if we reverse the procedure—start from the rear and work forward? It works! Employing this method, we use the designated outputs as designed and put in "test" inputs using the same principles of wall moving that we used for the top-down approach. The difference is that we start running our program in the middle and see if it comes out as expected. If not, we keep moving our START-RUN point closer to the output until it does come out.

This method is often very difficult to use because the data acquired during the bypassed input routines has to be "dummied up" into the proper registers and memory locations. This is where a good disassembler really helps when debugging object code. All of the registers can be readily altered on a step-by-step basis, to get things started.

If you're using BASIC, it may be necessary to use temporary routines and subroutines to be sure that every variable is correctly defined. If the problem is occurring in the middle of the program, then it's usually best to use both the end-in and top-down methods in order to box it in. It's very much like digging a tunnel under a river from both sides at once—when they meet in the middle, the job's done.

Hardware Tracing

If a system is dead, then the problem is usually hardware. Troubleshooting it with tracing techniques is fundamentally the same as the software techniques we've been discussing. The *principles are the same* but instead of using PRINT, END, STOP, SWI, etc., as temporary software output devices (indicators), we use oscilloscopes, pulse probes, DVMs, state analyzers, etc., to see the results at various points along the way. When working from the output into the program, we use waveform generators, oscillators, pulse generators, pulse injectors, software pulse train routines, etc., instead of the RUN-starting-at-line-#xxx that we used for software debugging.

Equipment/Knowledge Trade-off

In an earlier column (*Kilobaud* No. 20, August 1978), I had a lot to say about the reciprocal relationship between knowledge and test equipment. The more knowledge, intelligence and experience you have (or your friends have), the less test equipment is required, and vice versa. Of course, the bug will be found faster if there is plenty of both, but there seldom is! A good field serviceman for, say, a Tektronics terminal, can fix the terminal in less time than can a college professor, and with fewer tools.

Tools of the Trade

Signal tracing is an ancient art, probably as old as the field of electrical engineering itself. The optical galvanometer became the volt-Ohm-milliammeter and then the digital voltmeter. The ac voltmeter was augmented by the oscilloscope, the storage "scope" and the spectrum analyzer. Digital electronics and the microcomputer have spawned a new breed of test instruments. The pulse probes, for instance, can tell whether any probed point in the computer is on, off, high-impedance, high with negative pulses, low with positive pulses or single pulses (as short as 10 nanoseconds), all for less than $50.

Sign In, Please

In the future, we will probably see more signature analyzers in common use. This device does for the microcomputer what the digital voltmeter does for the television serviceman. By putting a known test signal into the computer, the signature analyzer can generate a (nearly) unique single-byte signature for key test points throughout the computer. If this corresponds with the value obtained from a schematic or a trustworthy circuit, then the troubleshooter moves on to the next point or uses the binary search principle outlined for debugging software.

At the present time, these devices cost as much as a small computer (too expensive for me), but as the cost of servicing micros goes up and the field of signature analyzers becomes more competitive, they may become *the* way to service the mass-produced micros of tomorrow.

Physician, Heal Thyself

Another new hardware troubleshooting trend of the future is to use the computer to diagnose itself! The best example is the ROM-based diagnostic capability designed into my PET. It even has an LED indicator built in. The problem is that Commodore won't tell me (or even some of their dealers) what's in it or how to use it, so I have to service it myself, the hard way. A real pain! Personal animosity aside, it is a commendable pioneering step in the field of troubleshooting.

Another current example of self-analysis is the Electronic Systems serial output board I use in the Apple II. The baud rate is controlled by a pot setting of a 555 (oscillator). As a Teletype driver it was a miserable failure because most Teletypes won't work reliably with only 5 volts driving the 20 mA loop (Teletype Corp. recommends at least 25 V and standard communication practice uses 40 V to 60 V). We had to redesign it to drive the Teletype with the +12 V and −12 V supplies.

Then came a pleasant surprise. A software frequency-setting program that worked like a dream was included. You entered the desired baud rate and your CRT became a digital frequency meter! It displayed the 555 adjustment both digitally and graphically. You could see it all happen as you tweaked the pot, and when you

had it optimized it set off a graphic celebration of victory! Seeing it do its thing can't help but make you wonder how far away we are from being able to dump in a cassette, load a disk or plug in a ROM and have the computer run a complete set of diagnostics on itself.

My TRS-80 has the rudiments of such a test in its appendix (my first one flunked it and was exchanged). As service data is compiled, more effective diagnostic programs can be written, but this can only be done by an aggressive manufacturer. With the current sellers' market there is little incentive, but the potential is there, and it could revolutionize the whole field of microcomputer troubleshooting.

If you can teach BASIC on an Apple II using software and *no* printed material, why not some interactive diagnostics? Of course, the fallacy occurs when the system is really dead, but with some printed material and a friend (or cooperative computer store personnel) with a similar machine, I find it hard to imagine any common fault that couldn't be traced and diagnosed without requiring an experienced troubleshooter and an expensive test lab. In fact, as the systems become more complex, this could become the *only* practical method of servicing tomorrow's mass-produced systems!

A Retrace

To sum up the discussion on tracing trouble, I'd like to leave you with the following thoughts.

- Hardware and software problems are debugged using the same basic principles—only the means for indicating a temporary output or originating an input are different.
- Follow a logical game plan for moving walls to box in your bug.
- Treat your problem like a brainteaser puzzle—there's no substitute for common sense.
- Approach your problem from both ends of the tunnel.
- Don't be afraid to try troubleshooting your own computer. Even if you fail occasionally, you'll have learned to think a little better, and that's probably one of the reasons you bought it in the first place.
- Your most powerful problem-solving asset is *synergistic synectics*—make a lot of friends!
- Divide and conquer.

It Seemed Like a Good Idea—at the Time

When this column was started in the July 1978 issue of *Kilobaud*, the editor and I both felt that there was a need "out there" for a sort of "Dear Abby" column on troubleshooting. We set up some guidelines and proceeded to fill up the two-month delay between writing and publication with some of the fundamentals of debugging the hardware and software problems of microcomputers. By that time we expected to be deluged with problems sent in by the 100,000 or so *Kilobaud* readers. It didn't happen.

This will probably be the last Troubleshooters' Corner column. If special situations occur (as in the case of the *EDN* article on troubleshooting the Apple II) or if there is some newsworthy development in this area, *Kilobaud* will keep you informed through articles on the subject. If you have some specific subject that you believe merits a feature article, write Wayne Green at *Kilobaud* about it. I am only one of several authors he could assign to fill a need.

Or better yet, if you have a solution that can really benefit others, write about it and send it in! I've found that trying to help others has been fun; you will, too. I have been preparing several feature articles on other subjects involving my 16 microcomputers, which may be appearing in *Kilobaud*—I hope you'll find them interesting.

KB CLUB CALENDAR

Steve Fuller

Panama City FL

The Panama City Computer Society (PCCS) was one of the first organizations listed in the Club Calendar when we started nearly a year ago. Secretary Steve Vickers wrote this month to say that membership has now grown to 44, and the group was planning a computer fair featuring 15 systems during the last week in September.

Meetings are held on the second Monday of each month at the Springfield Library, Springfield FL. Details on the club are available from Steve by writing to PCCS, PO Box 6079, Panama City FL 32901.

Microcomputer Investors Association

A sampling of articles in the latest issue of *The Microcomputer Invester* includes "Commodities—Are They Really Worth Analyzing," "Randomness and Predictability of Stock Market Prices" and "Measuring Your Stock's IQ." Six of the journal's ten articles include computer programs that implement their authors' applications.

The Association's annual dues are $30, and each member must submit one article per year for publication. For a membership application, send an SASE to Jack Williams, The Microcomputer Investors Association, 2415 Ansdel Ct., Reston VA 22091.

Got a Poly Hyphen?

Here's a newsletter for Poly 88 owners who have chosen to use another manufacturer's disk system. Thom Hogan announces the formation of the Poly-Hyphen-Disk Users Group (PhD.UG) to provide disk interface and software assistance.

The sum of $5 will get you ten newsletters featuring reviews of various disk drives and how to hook them up to your Poly, plus software information and help with system bugs.

Write PhD.UG, 719 Anna Lee Lane, Bloomington IL 47401.

Birmingham AL

The current slate of officers of the Birmingham Microprocessor Group lists Tom Bowen as president. Others include William Fleet, vice-president; Jeff Lyons, secretary-treasurer; and Joe Callaway, editor of the group's monthly publication, "Printout." The club meets on the fourth Sunday of each month (except November and December) at 2 PM.

Annual membership dues are $6 per family, and visitors are welcome at meetings. If you'd like to contribute articles or programs to "Printout", or would like more information on the club's activities, write BMG, PO Box 8072, Birmingham AL 35218.

AIM 65 Users Group

Rockwell's computer-on-a-board, AIM 65, will be the subject of a bimonthly newsletter to begin in January. Articles are being solicited, and subscriptions are available for $5 from Target, c/o Donald Clem, RR#2, Spencerville OH 45887.

Cleveland OH

The Cleveland Digital Group meets on the third Sunday of each month a 2 PM. For information on the Group's activities write to club secretary Louisa Jartz, CDG, 8700 Harvard Ave., Cleveland OH 44105.

Nobody's Perfect

For all the frustrated KIM-1 folk who have been trying to reach Jim Zuber, maybe his *correct* address and phone number will help! If you'd like to participate in his new San Fernando Valley area KIM-1 User's Group, write Jim Zuber, 20224 Cohasset #16, Canoga Park CA, or call him at (213) 341-1610.

This column is available for you to report on your club's activities such as regular meeting schedules, special events or programs, swap meets or any endeavor that will be of interest to your fellow hobbyists. If your announcement contains timely information, please send it at least two months prior to the date or dates mentioned in the announcement.

Kilobaud Club Calendar
c/o Steve Fuller
334 Sterling St. Unit A-3
West Boylston MA 01583

LETTERS

The Water's Fine

This is rather belated response to the April 1978 Publisher's Remarks—"Go off the Deep End," but I want to thank Wayne Green for his excellent advice in that column then.

As a result, I first narrowed my immediate computer choices to a KIM-1 or a Heath ET-3400 and studied the architecture and instruction sets of the 6800 and the 6502. Both are comfortable with hexadecimal data entry.

Then I investigated the external expansion possibilities and discovered companies that could provide such. I finally opted for the ET-3400 complete with Heath's Microcomputer Course. (I can usually learn more, faster, by assembling a kit than by circuit-tracing an assembled product.) Besides, the ET-3400 is aesthetically more pleasing to the eye than the KIM-1.

Now that I'm halfway through the course and approaching the breadboarding expansion of memory and I/O interfaces, I am less confused and more interested and understand the basics better than over a year's worth of reading various articles and books was able to provide.

The point is that I would still be reading, becoming more confused and waiting for the next state-of-the-art advancement had I not heeded Wayne's advice to "start small and get wet." Thanks, Wayne!

John R. Dye
Olympia WA

Well Integrated Company

I order integrated circuits and other circuit components quite often from your advertisers. In most all cases, I have been very satisfied with each company. One thing that always annoys me is additional charges. Usually, there's a minimum order charge, postage, handling and insurance. Then, if I call the order in, there's the cost of the phone call. Occasionally, the price of the order has doubled by this time.

One of your advertisers, however, eliminates these extra charges. I'd like to commend the service I get from Integrated Circuits Unlimited in San Diego CA. Their prices are very competitive and I've never received a bad component. They have no minimum order charge and not only pay postage and handling, but also pay for the telephone call with their toll-free number.

Shipping is fast. I called in an order on August 2 and today, August 4, received the order! They also honor several charge cards, which is another convenience. I highly recommend the company.

D. Keith Henson WB4BYH
Knoxville TN

Choo-Choo Change

The optical sensor of the article "Two Hobbies: Model Railroading and Computing" (July 1978, p. 26) can be greatly improved by replacing the binary-coded wheel with one that is Gray coded. The problem with a binary-coded wheel is that a change in position is associated with several bits changing states. This can result in gross positioning errors when a dividing line bisects a photocell.

The Gray code was devised for precisely this problem. It has the property that each transistor is associated with a single bit changing states. An example of a Gray-coded wheel is shown in the accompanying figure. An excellent tutorial of the Gray code is in the Mathematical Games column of *Scientific American*, August 1972.

The problem with the Gray code is that is must be converted to binary. The following algorithms perform the conversion.

Let $b_n, b_{n-1}, \ldots b_1$ be the bits in an n-bit number.

Binary to Gray code algorithm:
for i: = 2 *to* n *do*
if $b_i = 1$ *then* $b_{i-1} := > b_{i-1}$;

Gray to binary code algorithm:
for i: = n *down to* n *do*
if $b_i = 1$ *then* $b_{i-1} := > b_{i-1}$;

These algorithms can be implemented in simple loops consisting of a test sign, an exclusive OR and a circular shift. Anyone should be able to realize them in less than 10 instructions each.

Stuart W. Rowland
Mayfield Hts OH



A DIM Statement

Beware of recently manufactured Radio Shack TRS-80 systems. We received a sample last week with an apparent defect in the video monitor. If you run the sample programs on page 109 of the Level 1 user's manual you can check your system.

On three separate systems we've checked in the Boston area, all have a significant horizontal wavering in the display when the pixels are all lighted (i.e., when the program is completed). Also, there is a noticeable change in brightness as the display fills line after line.

Take it back before your warranty expires.

Robert Bonner
Brighton MA

An Enlightening Reply

Some slight wavering in video screens is not uncommon, but becomes apparent when the TRS-80's graphics capability is used to "white out" the entire screen. A severe skewing to the right after about half of the screen is painted indicates that a resistor in the monitor should be replaced. Radio Shack will be most happy to effect this repair for anyone experiencing this condition. Mr. Bonner should return his monitors to his local Radio Shack store for repair through our nearest Repair Center.

Dimming of the display when the screen is painted totally white is normal with our monitor, and quite common on monitors we have tested that are manufactured by other companies for microcomputer use. If Mr. Bonner feels the dimming on his is unusual, he should ask that it be checked by the Repair Center also.

I feel certain that if Mr. Bonner will give our repair organization the opportunity to correct his complaint, he will be more than satisfied with the results and the short repair time involved.

Ed Juge
Computer Products Manager
Radio Shack

For This Reader The '80's the One

It is most annoying to read letters to the editor like the one from Dave Caulkins in the September issue (p. 19). Similar letters disparaging the TRS-80 have appeared in other publications. Actually, in my opinion the TRS-80 is a best buy. Not the best computer around, and not for everyone; but for the large number of hobbyists and others who want the kinds of capabilities the TRS-80 has, it provides the most quality and capability for the money. I don't think the competition is even close.

First a word about those critical letters and, in some cases, review articles on the TRS-80. Maybe Radio Shack should have held up introduction of their machine until the Level 2 chip was available, since most of the

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criticism relates to limitations of Level I BASIC that do not exist with Level 2 (e.g., low recorder baud rate, lack of keyboard roll-over and limited string handling).

Level 1 is not bad when compared with other systems in its price range. In fact, it is quite good and can serve many needs quite adequately. What makes even Level 1 a best buy, however, is that it can be upgraded to Level 2 for only $99. When this is done, about $500 in value is added since, at least in my opinion, about $400 must be added to the cost of a Level 2 TRS-80 to purchase a system of equal quality and capability from another manufacturer.

My Level 2 TRS-80 with 16K RAM cost $789. For that sum I have: (1) Z-80 CPU. (2) Video interface featuring 16 lines of 64 characters (software changeable to 32 double-width characters per line for special effects), graphics and automatic scrolling. (3) 500-baud cassette interface with file name recognition and verify. (4) Microsoft-written extended (12K) BASIC in ROM that is the equivalent of top-of-the-line BASICs from other manufacturers. (5) 16K of RAM (about 15¼K is user available; the rest is used by the BASIC and for general housekeeping). (6) Standard size and configuration keyboard.

To my knowledge none of the popular systems, kit or assembled, with the possible exception of PET, can match or exceed these capabilities for $1200, let alone the under-$800 cost of my TRS-80. When price-comparing with another system that requires loading extended BASIC from tape, be sure to add the additional cost of 12K more RAM (for a total of at least 27K user available) in addition to the extra cost, if any, of the BASIC.

The PET might make the $1200 price reference with comparable capabilities, but in my opinion it does not match the Level 2 TRS-80 at the same price. For $795 the PET buyer gets a good (8K) BASIC in ROM, but not as good as Level 2; only 8K of RAM and a nonstandard keyboard that even PET owners dislike. However, a monitor and cassette are integrated into the one-piece unit and included in the cost. These are extra-cost items with the TRS-80 (included in the "system" cost, but the TRS-80 can be purchased without them). So a potential buyer must pay his money and take his choice when deliberating between these two systems. For my money, I chose what I consider to be the better basic (and BASIC) machine and purchased the recorder and a very good surplus monitor separately at a cost considerably lower than if purchased from RS.

Concerning quality of the TRS-80, I can only say my system has operated flawlessly. Recorder problems, common to most systems and the most frequently read complaint about the TRS-80, have been minimal and traceable either to operator error or some "bargain" surplus tape I purchased.

The best-buy status of the TRS-80 can only be improved as manufacturers of peripheral equipment respond to the large potential market of TRS-80 owners. *Kilobaud* and others are predicting that soon, if not already, there will be more TRS-80s than all other makes combined.

A parting word for Dave Caulkins. I do agree with the last sentence of his letter, although my interpretation is undoubtedly different from his. Indeed the PET and TRS-80 are not of equivalent quality.

Hal Brown
King of Prussia PA

TV or not TV

In the September 1978 issue (p. 18) Dr. Meyersfield inquired about hooking a standard TV to a TRS-80 system. This is the same approach that I took, since the output is a standard video signal. I first attempted to use an rf modulator, but had limited success with it due to limited bandwidth.

Next, with the help of a Sams Photofact schematic of my set, I tried a direct tie-in to the first video amplifier and achieved a readable picture. However, the characters still ran together somewhat, so I extended the bandwidth a little by removing the sound IF traps. The final change gave a display almost the quality of the TRS-80 monitor. The bandwidth required for the TRS-80's 64-character line is more than most unmodified sets can handle.

Sets not to use for conversion are color and small (diagonal of nine inches or less) screen b&w models. Also beware of the shock hazard involved in using sets with a line-connected chassis. I found Don Lancaster's *TV Typewriter Cookbook* (stocked by Radio Shack) very helpful with the process.

Robert A. Lacy
Schenectady NY

I read with interest Dr. Meyersfield's letter in the September 1978 issue of *Kilobaud* because I also saw no sense in paying an additional $200 for a CRT monitor. (I bought the Level 1 4K machine only.) However, I was shocked when I read the editors' reply. You said parenthetically, "The Radio Shack has an opto-isolator built in so more than a simple TV modulator is required."

What, then, is a Pixie-Verter? I am successfully using an unmodified Pixier-Verter and 12-inch b&w TV. The setup works great. Naturally, it is not as good as direct video, but for the 16 lines of 64 characters and 48 × 128 graphics, it is sufficient. If there is something special about a Pixie-Verter, I would like to know about it.

I have subscribed since Vol. I, No. 1, and, except for this matter, have been satisfied with your magazine.

Jerry Owen
Hopewell VA 23860

Marketable?

I am writing to inquire whether you feel there is a market for a computing service I am considering offering: the production of high-quality output copy, suitable for offset printing, from Tarbell coded audio tapes or minifloppy disks. This idea has come to me after observing the unsuitability of most small-computer output devices for preparation of copy for printing. The quality, for example, of programs reproduced in journals is terrible.

I see two potential classes of users for this service: publications (newsletters and magazines) that use word-processing systems for preparation of their text; software publishers, who need to print programs that would be impractical to retype.

Because the input would be supplied by the customer, the cost would be lower than regular typesetting services, and the accuracy, particulary in reproducing programs or object code, would be improved.

I currently own the typesetting equipment and am working on the interface between it and a microprocessor, and hope to have it up and running by September.

Daniel Eisenberg
1507 Sharon Rd.
Tallahassee FL 32303

Getting good copy on program listings has been a bear in the past. We've tried setting 'em in type, but there seems to be almost no way to get such a job done without errors . . . or at least a large waste of time. We've been working toward a solution to this for Kilobaud *(and Instant Software) via a couple of the Micro Term Selectric II systems. We have these presently connected to the TRS-80 and PET systems and hope to have them I/O with most of the other* Kilobaud *lab systems soon. As far as providing a service is concerned, you are up against the same problem we are with cassettes: a wide variety of formats. I think you'll find that not more than 10 percent of the systems can yet use a Tarbell format, so you'll either have to get more formats covered or else limit your business to that group. I tried to stop this proliferation of formats when I organized the Kansas City meeting back in 1975.—Wayne.*

National Computer Tournament for the Prisoner's Dilemma

Looking for a challenging project for your strategic instincts and your programming skills? This computer tournament may be for you. There is no charge to enter.

The tournament is based on a game called the Prisoner's Dilemma. In the Prisoner's Dilemma there are two players. Unlike most games, such as chess, the two players are not in total conflict. In fact, both can do well or both can do poorly.

Here is how the tournament works. The game will be played for an average of 200 moves, and in each move, each player can choose either to cooperate or to defect. If both cooperate, both do well. But if one defects while the other cooperates, the defecting player gets his highest payoff, and the cooperating player player gets taken for a sucker and gets his lowest payoff. The catch is that if both defect, both do poorly.

The precise payoffs in the tournament for a given move are 3 points each if both cooperate; 5 points to a player who defects while the other cooperates, with 0 points to the sucker; and 1 point each if both defect. The score of a player in a single game is his or her total over all the moves.

To win the tournament you have to get the highest total score summed over all the games you play. Therefore your object is to get a good score in each separate

game, but *not necessarily* to get a better score than the player with whom you are currently playing.

To join the computer tournament, you submit a program written in BASIC or FORTRAN IV which will be a decision rule for the selection of the cooperative or the defecting choice at each move. The decision rule may be based on the history of the game so far. For example, a simple and effective decision rule is tit for tat: cooperate on the first move, and then do exactly what the other player did on the previous move.

Quite sophisticated decision rules can be written in as little as 25 lines. This tournament is part of a research project to understand the nature of skillful performance in a two-sided environment that is partially cooperative and partially competitive.

Each person who completes an entry will receive a report describing the results of the tournament. The winner will receive a handsome engraved trophy.

To get further details on the tournament, write to Professor Robert Axelrod, Institute of Public Studies, University of Michigan, 506 E. Liberty St., Ann Arbor MI 48104.

Info Needed

I recently purchased a used Singer model 4325 helical line printer. It uses an HSP-30 printer. The unit seems to be in good shape, but I am in need of any information I can get as to the electronics portion of the unit. Any information would be very much appreciated. Keep up the good work on a great magazine.

Eugene Tetzlaff
305 Poplar St.
Onalaska WI 54650

On the Mark

It's a tribute to your magazine that people get upset if they don't receive it on time since it's always timely and absorbing! The photocoverage of the Faire (June, July 1978) was wonderful . . . not too many pictures at all . . . almost as much fun as being there.

So far your editorial mix has been right on the mark; don't change a line of it.

Ted Wolff
New York NY

BOOKS

(from page 18)

as of 1973 had seen no betterment of the 1967 computation by a CDC 6600 to 500,000 places in 28 hours.

If you don't mind a little bit of political commentary on mankind's inhumanity and foolishness (the remarks are not unjustified), you'll find *A History of Pi* a fascinating history of mathematics, famous and infamous men . . . and plenty of good anecdotes. The book is very readable. It is better if you know a little algebra and plane geometry and better still if you have had a smattering of trig and calculus. Nevertheless, this is a fascinating story by an author who has done his homework and uses his pen both as a sword and a torch.

John Martellaro
New Mexico
State University

THE BASIC FORUM

(from page 17)

easily be modified to replace the exchange with a shift that moves the matching item to the top and shifts all remaining items down one position.

"Keep up the good work."

Sort techniques like the one Kenneth used are more elegant and less "brute force" but not necessarily better from a memory time standpoint. Bob Lurie submitted a string version that compares elements charater-by-character as you will soon see.

"You were right about this being a deceptively simple problem. I spent hours before I worked out all the bugs! I find that judicious use of commands such as PRINT "LINE XX X P=";P can be very helpful in following program flow and tracing the position of the pointers. These statements can all be eliminated later.

"The title I have given to the program (Program 5) is intended to suggest that it is a member of a general family of programs. I intend to incorporate a routine >= 2=1 in a larger program I am now writing.

"I enjoy your column very much. Computing is what computers are all about. I hope that when APL becomes more generally available—I'm studying it now—you'll expand your column to include it."

Finally, two additional points of interest. Ronald Anderson, 3540 Sturbridge Ct., Ann Arbor MI 48105, sent us an interesting solution. He solved the problem two ways using 6800 machine language and BASIC. The results shown in Table 1 clearly indicate that we pay for ease of programming in BASIC with memory inefficiency and greatly increased execution time. Everett Rubel, S.R. 90574, Fairbanks AK 99701, sent us a *one* line solution—written in APL! We couldn't help but be impressed.

The large number of entries precluded our giving details of all, but we have provided in Table 2 a list of the entrants' names. We are sorry more could not be printed.

A New Problem

This month's programming problem is a favorite. It is a real classic that literally predates computers by centuries. We know it as Josephus' Problem. For background on the problem we turn to Maurice Kraitchik in his Dover book *Mathematical Recreations.*

According to legend, the famous Jewish historian Josephus saved his own life by a carefully conceived strategem. After the Romans had captured Jotapat, Josephus and 40 other Jews took refuge in a cave. His companions were resolved to die rather than fall into the hands of their conquerors. Josephus and and one friend, not wishing to die yet not daring to openly dissent, feigned to agree. Josephus even proposed an arrangement by which the deaths might take place in an orderly manner. The men were to arrange themselves in a circle; then every third man was to be killed until but one was left, and he had to commit suicide. Josephus placed himself and his friend that they alone survived, then escaped.

Develop a BASIC program that can be used to determine the elimination order for the general case of Josephus' Problem (i.e., set up for the elimination of each m^{th} person in a circle of n persons. Use the data given above as a test. For n=41 and m=3, Josephus and his friend should occupy places 16 and 31. Be sure to include (1) name of computer and BASIC, (2) execution time (exclude printout) and (3) total bytes of memory used. Send correspondence to:

The BASIC Forum
PO Box 7082
Tyler TX 75711.

Method	Bytes Used	Run Time	Programming Time
6800 machine code	900	few .1's second	10 hours
SWTP BASIC	≈10,000 (including BASIC)	43 seconds	1/2 hour

Table 1. Ronald Anderson's solution to "Casting Out Duplicates."

1. Ronald Anderson
2. Sandy Aubin
3. Richard M. Bash/Helmut Zinn (from Germany)
4. Craig Bradley
5. Kenneth Busch
6. Ross Cooling
7. Courtney Ellis
8. Clive Frazier
9. David Garson
10. Gary Gaugler
11. Ken Graham
12. Peter Granzeau
13. Rodney V. Hamilton
14. Morton Harwood
15. Bob Healey
16. Joe Holliday
17. Ralph Iden
18. Knute Johnson
19. Ann C. Johnston
20. John Jordan
21. Tony Kalar
22. Joe Kopsho
23. Daniel Kott
24. Richard Lambke
25. P. LaPlante
26. Dave Leestma
27. Robert E. Lehman
28. Rand Lewis
29. Robert Luckey
30. Bob Lurie
31. John W. McGaw
32. Alan McIlhenny
33. Robert A. McIvor
34. Greg Maggs
35. Theodor Mahler
36. Jim Martens
37. Joseph W. Mintzer
38. Norton C. Richardson
39. Brian Riley
40. Everett Rubel
41. Joseph Schaffner
42. Marv E. Schwanbeck
43. Nancy Schwartz/Carol Ascolillo
44. Buck Selby
45. Joseph Shapiro
46. Paul A. Sisul
47. Robert R. Urschel
48. George O. Wright
49. Su-Ming Wu

Table 2. "Casting Out Duplicates" entrants.

David Koh, M.D.
Dept. of Cardiology RG-20
University of Washington
Seattle WA 98195

Raster Scan Graphics for the 6800

(Part 1: The Hardware)

Is there any end to the modifications—and additional capabilities— that can be added to the TV Typewriter II? Probably not. To show you what we mean—here's a real eye-opener.

Shortly after building my SWTP 6800 system I set about adding graphics capability to it. My choices at the time were analog vector graphics or bit-mapped raster scan graphics. I had seen several 6800 vector systems in operation and was impressed by the results. I was also impressed by the amount of processor overhead needed to maintain the display and the difficulty in displaying solid white areas. In addition, I did not own a large-screen vector display device. I did have a high-quality TV monitor, however, that I used with a CT-1024 TVT-II as my terminal.

For these reasons I chose to implement raster scan graphics. The following describes how a high-quality graphics system can be built around the SWTP 6800 and TVT-II.

There were several requirements I had in mind when developing this graphics system.

1. *High density.* I wanted single dots, not squares or blocks, and enough density to display curves in a reasonable manner. This design uses 256 horizontal dots, which, I feel, is a minimum for serious graphics work.

2. *Static display.* I wanted the system to have its own memory so it would display whatever was stored there, regardless of what the MPU was doing. The MPU would be free to perform its own tasks without having to constantly refresh the display.

3. *Fast update.* I was interested in animation and wanted to be able to change the picture as rapidly as possible. This dictated a shared memory approach in which the MPU could read or write graphics RAM directly through the system bus. Transmission of data through a serial or even parallel I/O port would not be fast enough.

4. *Memory conservation.* This would be a side benefit of memory sharing. The graphics RAM looks like any other RAM to the processor and could be used as such to store programs or data when graphics was not being used.

5. *Straightforward design.* I wanted neither hard-to-find parts nor critical adjustments in the circuit.

6. *Ease of construction.*

7. *Low cost.*

I looked at what was available on the market. Then, as now, there simply were no commercially available high-density graphics boards for the Southwest bus. The GT-6144 was just too coarse for my needs. The only alternative was to build my own.

I saw a promising-looking graphics system design published by Thomas Buschbach in late 1976. The only catch was that it was designed for a Digital Group 8080 system and Digital Group video interface. Even though my microprocessor chip, processor board, system bus and video system were all different, I decided to see if I could duplicate the results.

What has evolved over the months is a virtually redesigned circuit that has finally satisfied my requirements. Designing, and especially debugging, it has been a tremendous educational experience for me. I present this article with the hope that some of the many SWTP 6800/TVT-II owners will try their hand at it and discover the exciting world of graphics.

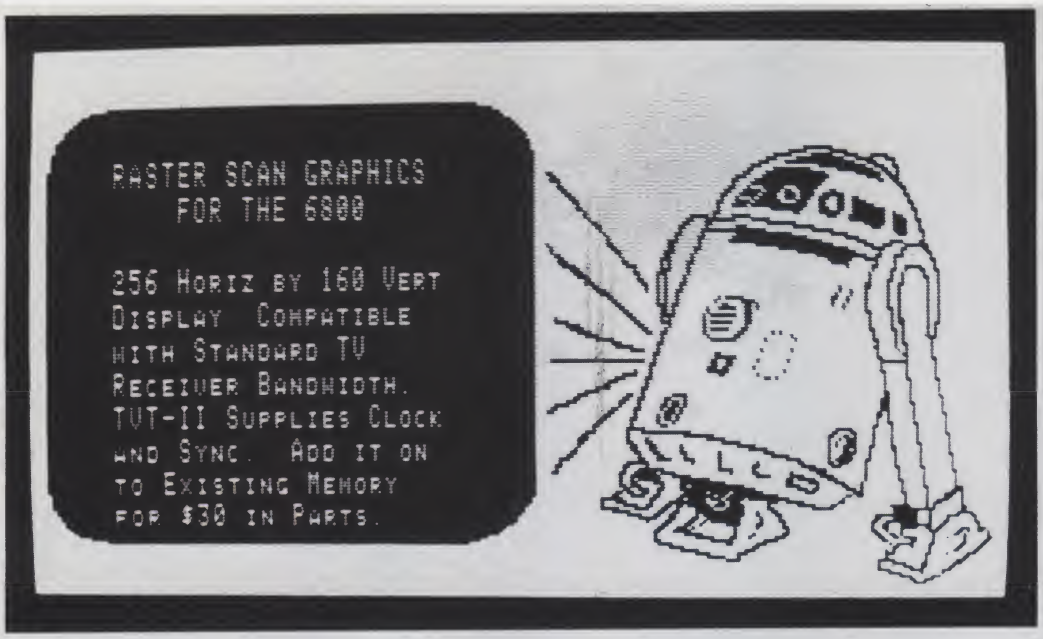
The circuit is sufficiently complex that I do not recommend it as a beginner's first project. Anyone who has built a few IC projects from scratch should have little trouble with it. Since no critical adjustments or alignment are needed, it should work the first time if constructed properly. As in all large digital circuits, though, Murphy's Law dictates that at least one wiring error will be made. An understanding of how your computer and terminal work, an oscilloscope and common sense should see you through, however.

Design Considerations

I decided to use signals from the TVT-II to supply the timing for my graphics system. This has several advantages: it reduces cost and complexity and takes advantage of the phase lock loop of the TVT-II's timing chain. This synchronizes the vertical and horizontal sweep to multiples of the power-line frequency. The result is a rock-steady display free of the wavering that commonly occurs with crystal-controlled clocks when the power-line frequency is slightly off. Using TVT-II timing also allows simultaneous display of graphics and alphanumerics on the same monitor.

Centering the graphics picture is also done by the TVT-II. The dot counter reset and line counter increment pulse is provided by a signal I call $\overline{\text{LOCKOUT}}$. Not only does it provide the proper one-per-line pulse, but it also locks out the dot clock until the TVT-II left margin set monostable times out. This means the same adjustments for TVT-II margin and line lengths will also set those for graphics.

There was one catch to using the TVT-II dot clock. Each character in the TVT-II occupies a 7 x 10 matrix. Horizontally, there are five character dots and two



blank "undots" for spacing; vertically, there are seven character lines and three blank lines for spacing. Since there are 16 lines of 32 characters, that means there are 224 by 160 dots available. No matter how you configure the graphics RAM you end up wasting bits trying to match this format. 224 is also an awkward number to deal with when you're writing machine-language graphics software.

The solution was to modify the TVT-II format from five dots and two undots across to five dots and three undots across per character. The change in circuitry amounted to moving one IC pin from +5 to ground. The new TVT-II format is virtually indistinguishable from the old one and in no way affects normal terminal operation. The result is a 256 x 160 dot matrix that requires 5124 bytes, exactly 5K, to support.

My graphics RAM consists of a modified Southwest 4K memory board. This approach eliminated the chore of wiring up some 40 1K RAM chips plus support chips from scratch. In addition, half of the necessary buffers are already on this board. Turning the 4K board into a 5K board proved to be a simple matter accomplished by piggybacking eight additional 2102L1 RAM chips. The remainder of the circuitry is on a small auxiliary board.

For the purpose of the following discussion we can think of the graphics board as a rudimentary processor. Its sole function is to cycle through 5K of memory converting parallel data into a serial stream for the video modulator. Since there is another processor on the bus, namely the 6800, capable of accessing the same block of memory, there must be a way to settle simultaneous access conflicts. This system gives precedence to the MPU.

The RAM chip address and data lines are isolated from the main system bus and are normally driven by graphics circuitry. When a valid address appears on the system bus that the graphics board recognizes as being in its range, then it is allowed to pass through to the RAM address lines. At the same time, the graphics on-board address generators are disconnected, effectively giving control of RAM to the MPU.

If this is a read operation, then true data will become available after the access time of the memory passes. At the appropriate instant, the data are strobed onto the system bus to be read into the MPU. For a write operation the address lines are set up by the MPU, data are applied to the RAM chips and the system write pulse is allowed to reach the RAM chips. At all other times, we must keep each processor oblivious of what the other is doing. In particular, we must make sure that the RAM chips will never put any data on the system bus unless the MPU requests them to.

Similarly, the system write pulse must never reach the RAM chips unless the MPU has control of their address lines. Isolation is provided by Tri-state buffers that are enabled and disabled by on-board address decode and control logic circuitry. It turns out that we can leave the RAM Data In lines always enabled since write operations will occur only during MPU accesses.

The write pulse requires special handling. The address applied to the RAM chips must remain stable immediately before, during and after the write pulse occurs. There must not be any overlap or we will write into memory locations other than what we expected. Remember that our control logic has to decode the system bus address first before allowing it to pass onto the RAM chips. Because of this delay the address and write pulse reach the RAM chips simultaneously.

Trying to correct this was by far the most difficult task in designing this circuit. Simply delaying the write pulse with a few TTL gates in series resulted in trailing edge overlap. Using a one-shot multivibrator to generate the write pulse worked but required critical RC filtering to prevent false triggering on noise.

I tried using a circuit similar to the Motorola 2 phase non-overlapping clock driver in the 6800 data manual. This seemed to work for a while until I tried running long memory diagnostics. It seems that repeated write cycles will warm up the 2102L1 memory chips by drawing more current in this mode. This lengthens certain access times internal to the chip and alters the write pulse requirements. There was no telling how many TTL gates I'd have to string together to get the right delays.

In the end the best solution turned out to be the easiest. I simply gated the write pulse with a Phase 2 clock, which never overlaps an address. Even though the resulting write pulse is narrower by a factor of two, it has caused no problems and should not, unless very slow memory is used.

The subject of sparkle comes up whenever you deal with DMA graphics. This occurs when the MPU accesses the memory at some location other than the one that is currently being displayed. Whatever that first location contains gets *loaded* into the shift register and output to the monitor. If it is not the same as the second location

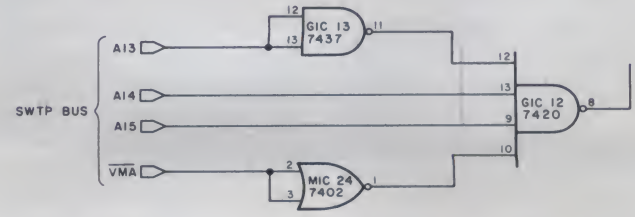


Fig. 1. Alternate board select circuit for C000-D3FF.

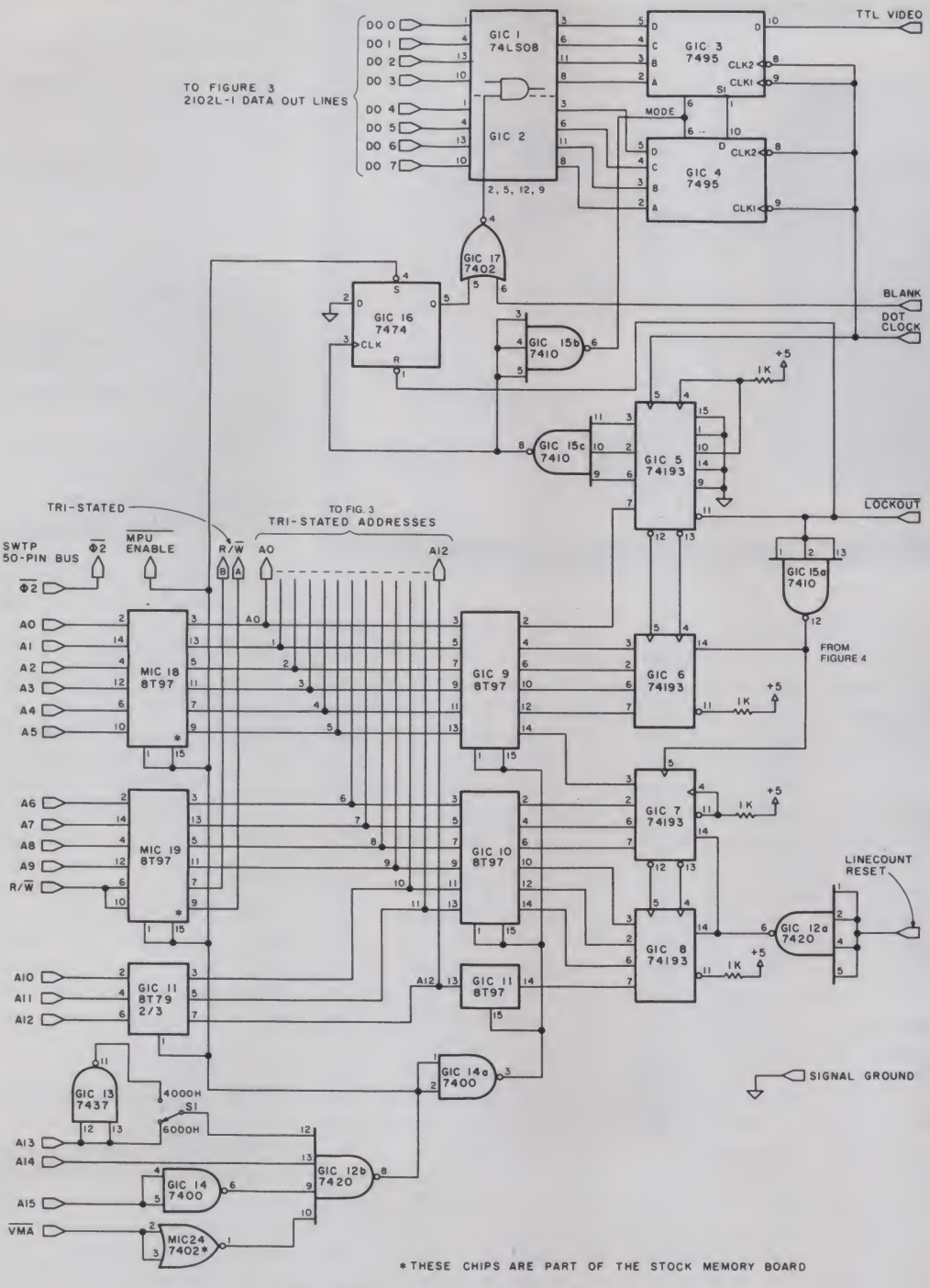


Fig. 2. Graphics system logic diagram.

(as it very likely is not), then it appears as a momentary glitch on the screen. When frequent accesses are made, this sparkle resembles a snowstorm and can be very objectionable.

The usual solution is to stop the MPU and allow it to run only during horizontal and vertical retrace. The 6800 cannot be stopped in a suitable manner to use this scheme. In addition, I did not want to slow down the MPU since I was interested in exploring animation and 3-D.

My answer to the problem is to load zeros into the shift register during an MPU access. This has the effect of forcing an 8 bit all-blank sparkle. This black-on-white pattern is much less noticeable than random white-on-black sparkle and is virtually invisible if a medium persistence phosphor is used. The screen does not blank out during MPU accesses, and the MPU runs at full speed using this scheme.

High memory seemed to be a logical place to put the graphics RAM. Keeping it separated from main memory protects it from being clobbered by programs like BASIC that search for the end of contiguous memory on initialization.

My system has 16K of main memory at locations 0000 to 3FFF and 5K of graphics RAM at 6000 to 73FF. A toggle switch on the board moves graphics RAM down to locations 4000-53FF when I need 12K of contiguous memory for word processing, assembling large programs, running long BASIC programs and the like. For fully expanded systems Fig. 1 shows how to wire the board for C000 to D3FF, a region where there is currently no conflict in the SWTP 6800 MIKBUG system.

At present, this system does not support color or intensity modulation (Z or gray scale). There is no reason why the basic design cannot be expanded to include these features, but to do so requires more memory, which would best be done by employing higher density RAM chips.

How It Works

For this section and throughout this article, the following convention will be used for numbering ICs: ICs that already exist on the TVT-II board are prefixed by TIC, followed by their number as found in SWTP documentation. Existing memory board ICs are labeled MIC and similarly numbered. All new chips are considered part of the graphics system and are labeled GIC.

Main system timing is derived from the TVT-II dot clock (see Fig. 2). GIC 5 and 6 are the dot counters that count down the dot clock. A $\overline{\text{LOCKOUT}}$ pulse, which occurs once per line, both resets the dot counters and increments the line counters GIC 7 and 8. The latter are reset by the $\overline{\text{LINECNT RESET}}$ pulse from the TVT-II.

These four counters form the graphics address generator. Their outputs drive the 13 RAM address lines A0-A12 to cycle continuously through the 5K of memory in ascending binary sequence.

GIC 15C is a triple input NAND gate connected to GIC 5 as a divide-by-8 strobe. Its output is connected to the mode control of shift registers GIC 3 and 4 and causes a new byte to be parallel-loaded every eight dot-clock cycles. The dot clock is also connected to the shift register clock inputs that shift out the eight bits serially, least

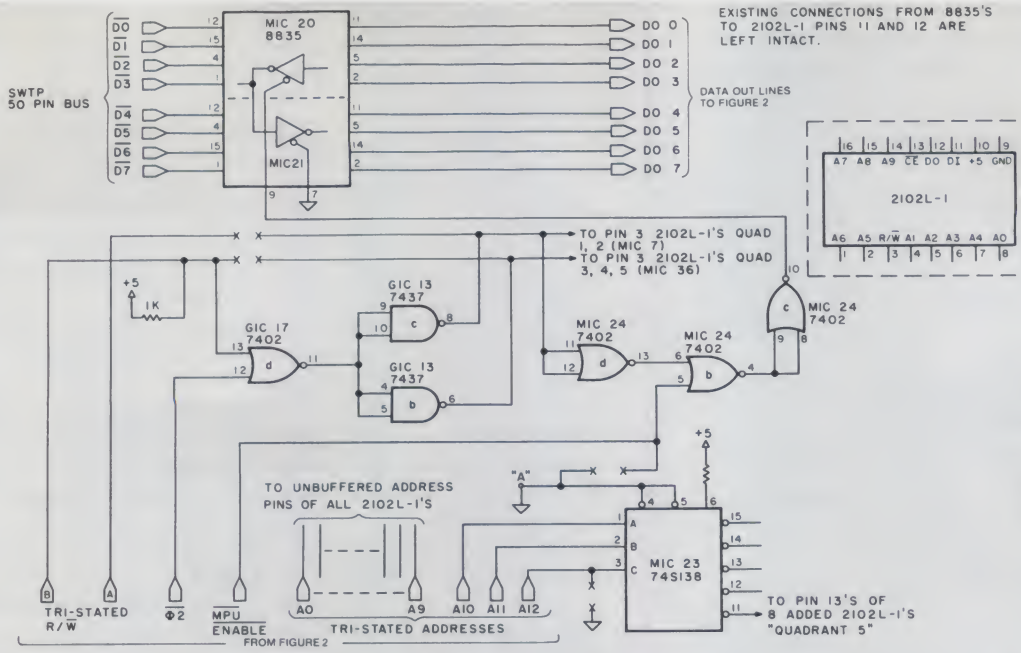


Fig. 3. Memory board details.

significant bit first, to the TVT-II video section. Note that GIC 5 is preset to binary 0100, instead of actually cleared. This lines up the graphics image exactly with the TVT-II alphanumerics.

GIC 1 and 2 are eight AND gates with each input connected to a RAM chip Data Out line. Data will not appear at their outputs unless the other inputs are held at a logic high. The BLANK signal from the TVT-II sets these inputs low, forcing the shift registers to load zeros. This produces the black top, bottom and side margins.

MPU accesses are latched in flip-flop GIC 16, whose output also forces blanks. GIC 16 is not reset immediately at the end of the MPU access. Instead, blanking continues until the next shift register load operation occurs. This arrangement prevents false data from being loaded should the time from end of MPU access to shift register load be less than 2102L1 access time. In this way sparkle is further minimized.

MIC 18, 19 and ⅔ of GIC 11 form the SWTP bus address buffers. GIC 9, 10 and ⅓ of GIC 11 form the graphics address buffers. Enabling of these Tri-state buffers is controlled by address decoder GIC 12 and inverter GIC 14A. S1 sets the board address range.

With A13 not inverted, an MPU access will occur for any address that appears on the system bus in the range 6000-7FFF (though with 5K, 73FF is the last alterable location). Inverting A13 sets the range to 4000-5FFF (last location 53FF). Fig. 1 shows how the memory range can be set for other locations if desired.

In Fig. 3, GIC 17D produces the RAM chip write pulse by NORing Phase 2 and the system write pulse. GIC 13 B and C are merely high-current buffers needed to drive 40 paralleled 2102L1 write pins.

MIC 24 B, C and D enable the bus driver sections of MIC 20 and 21 (8835 data bus transceivers) during MPU read operations. MIC 23 is a 74S138 1 of 8 decoder that enables the appropriate 1K bank of RAM chips according to address lines A10, 11 and 12. Note that these address lines are not buffered on the unmodified memory board and have been buffered through GIC 11.

Fig. 4 shows modifications to the TVT-II. Pin 2 of TIC 24 is disconnected from +5 V and grounded to convert from seven dots per character to eight. BLANK and DOT CLOCK signals are derived using spare gate sections on the TVT-II board. The DOT CLOCK must be inverted through TIC 15A for proper operation. LOCKOUT and LINECNT RESET are taken directly from appropriate points in the TVT-II circuit. GIC 18, which is added to the TVT-II, allows graphics display, alphanumerics or both on the same monitor. TIC 4A is used to divide the TVT-II dot clock by 2 if the circuit has been modified for 64-character-per-line operation.

Construction

Most of the circuitry resides on an auxiliary board that mounts to the 4K memory board. One chip is added to the TVT-II. The actual construction technique is left to the reader. I would recommend wire-wrapping, even though I didn't use that technique. Leads should be kept as short as possible, and heavy gauge +5 and ground buses should be used. In addition, be sure to bypass power and ground with a 100 uF

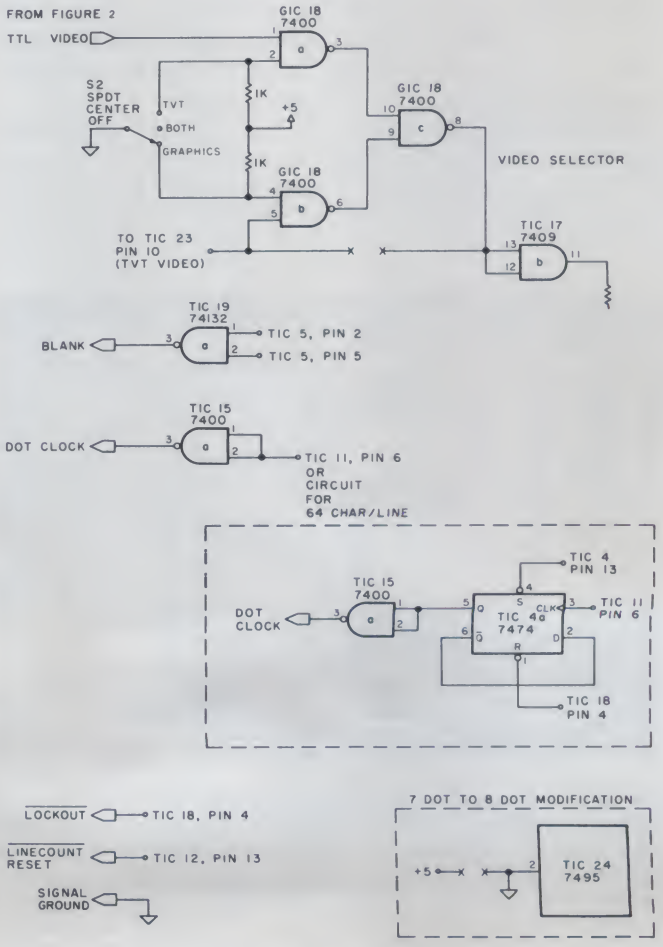


Fig. 4. TVT-II mods.

	1 SWTP 4K memory board
	1 prototyping board and edge connector
	1 7805 5 volt positive regulator and heat sink
	8 2102L1 RAM.chips
GIC 5,6,7,8	4 74193 binary counters
GIC 9,10,11	3 8T97 or 74367 Tri-state buffers
GIC 12	1 7420
GIC 14,18	2 7400
GIC 13	1 7437
GIC 17	1 7402
GIC 16	1 7474 D flip-flop
GIC 3,4	2 7495 4-bit shift registers
GIC 1,2	2 74LS08
GIC 15	1 7410
S1	1 SPDT toggle switch
S2	1 SPDT center off toggle switch

Resistors: all 1k, ¼ watt 10 percent for pull-ups.

Capacitors: 1 100 uF 15 volt electrolytic and several .01 uF disk ceramics for bypass.

Misc.: Ribbon cable, wrap-wire, IC sockets, 16-pin header, Molex socket pins.

Table 1. Parts list.

electrolytic capacitor and several .01 uF disk ceramics.

The prototype was built using a Radio Shack prototyping board (276-152), IC sockets and point-to-point wiring. The ICs on the auxiliary board interdigitate with those on the memory board, and, consequently, the whole assembly fits in a single slot of the SWTP motherboard (see Photos 1 and 2).

This is probably not possible if wire-wrapping is used, unless the socket pins are cut down. I piggybacked several TTL chips on top of existing memory board chips to reduce the number of wires going onto and coming off the auxiliary board. If this does not suit some readers, then there should be enough room to squeeze these chips onto the auxiliary board with careful layout. Table 1 contains a parts list for the modification and Table 2 lists the IC power pin-outs.

The first step is to verify that all computer-system components, including the TVT-II, SWTP 6800 and the 4K memory board, are working. Be sure the memory board is functioning perfectly before attempting to modify it. If you are constructing any part of the system I urge you to use sockets for all ICs.

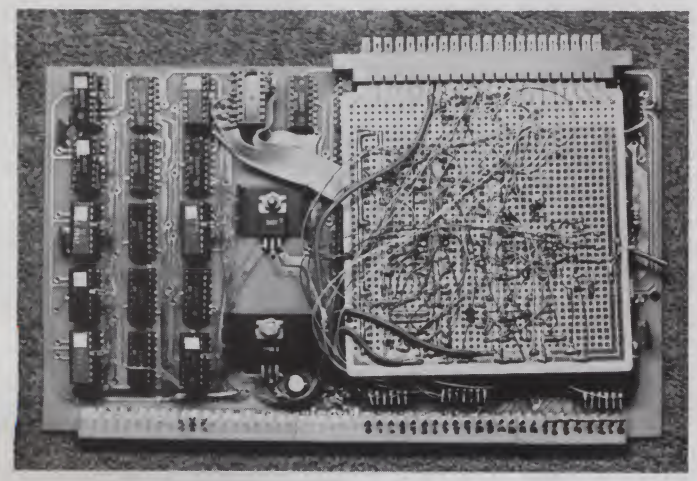


Photo 1. The completed auxiliary board mounted to the modified 4K memory board. Interconnections to the TVT-II are made by the edge connector at the top of the auxiliary board. Note the eight new 2102L1 RAM chips (marked with white squares) added to the memory board and the new regulator and heat sink. A 16-pin DIP header, which plugs into an IC socket piggybacked atop MIC 25, provides an easy connection point to the ten low-order RAM address lines.

	GND	+5
74LS08	7	14
7495	7	14
7400	7	14
7410	7	14
7420	7	14
7402	7	14
7437	7	14
7474	7	14
74193	8	16
8T97	8	16

Table. 2. Pin-outs for IC power connections.

The following sections describe in detail the necessary modifications and additions.

TVT-II

The TVT-II requires minimal modification.

1. Convert from seven dots per character to eight dots by lifting pin 2 of TIC 24 from +5 and connecting to ground. This is most easily done if the IC is socketed. Pin 2 can be carefully bent out straight and reinserted in its socket. Connection to pin 2 is made by soldering directly to it or to a Molex socket pin which is slipped over the IC pin. If the IC is soldered to the board then you must cut the pin carefully near the board using a fine tool. Readjust TVT-II R6 to center the characters.

2. Locate pin 10 of TIC 23. On the bottom side of the board a trace leads from it to a plated hole. Cut this trace carefully using a sharp blade. This breaks the video path to TIC 17B pins 12 and 13.

3. Add GIC 18 (a 7400) to the TVT board and wire it as shown in Fig. 4 to form the video selector. S2 can be mounted up to several feet away from the board for convenient selection. An easy way to mount the IC is to glue it on its back to the bottom of the PC board using a cyanoacrylate glue such as Super Glue. Connections can be made by soldering directly to the pins. Pin 1 of GIC 18 is the TTL VIDEO INPUT line.

4. Wire the unused section of TIC 19 as shown in Fig. 4. The output of this gate is the BLANK line.

5. Form the DOT CLOCK line by inverting the TVT-II dot clock through the unused section of TIC 15. If you have converted your terminal to 64 characters per line then use the unused section of TIC 4 to divide your TVT-II dot clock by 2.

6. Locate TIC 18 pin 4. This point will be the $\overline{\text{LOCKOUT}}$ signal.

7. Locate TIC 12 pin 13. This will be the $\overline{\text{LINECNT RESET}}$ signal. Incidentally, the Southwest schematic shows this pin incorrectly connected to TIC 20 pin 13; it is actually connected to TIC 13 pin 8.

8. Cut six lengths of insulated wire just long enough to reach to the computer and solder one to each of the five signal lines we created in the above steps and signal ground. Do not omit the signal ground even though your terminal may be grounded through the power line or RS-232 link.

Memory Board

Several modifications are made to the 4K memory board. The most visible is the addition of eight RAM chips to produce a 5K board. The board select circuitry is also modified, and several lines need to be isolated through Tri-state buffers.

1. I strongly suggest labeling the bottom Molex edge connector of the memory board with each pin's function to avoid making errors.

2. Add an extra 7805 5 volt regulator to supply the auxiliary board. Mount it with another heat sink on top of the memory board lower regulator using a longer screw and metal spacers to ensure metal-to-metal contact for good heat transfer. Bend the input and ground pins down and solder them to the corresponding pins of the lower regulator. Solder a heavy flexible wire to the output pin. The other end will be attached to the 5 volt bus on the auxiliary board.

3. Solder a heavy wire to ground near the Molex edge connector. The other end will be attached to ground on the auxiliary board.

4. Lift the following IC pins either by bending them out and reinserting the ICs in their sockets or by cutting and bending if they are soldered in.

(a) MIC 18 pins 1 and 15

(b) MIC 19 pins 1 and 15

(c) MIC 23 pins 1, 2 and 3

5. Three foil cuts are necessary, and a pull-up resistor must be added.

(a) Trace the connection from MIC 19 pin 7. Cut the trace as it goes around C7 at the lower left corner of the board on the component side. Be sure to cut it before it reaches any of the R/W pins. Note that this trace has a plated through hole near pin 9 of MIC 35. Locate the three plated through holes in the +5 line near pin 9 of MIC 36. Solder a 1k ¼ Watt resistor between these two points.

(b) Cut the trace that goes between MIC 19 pin 9 and MIC 7 pin 3 on the component side of the board.

(c) Carefully cut the trace on the component side running from MIC 23 pins 4 and 5 to MIC 24 pin 5.

6. Remove the board address select jumper and tie point A to ground by connecting it to MIC 23 pin 8. We have now bypassed MIC 22, which can be removed from its socket if you wish.

7. Take eight new 2102L1s and carefully bend each pin 13 straight out to the side. Piggyback these chips on top of MIC 26, 28, 30, 32, 34, 36, 38 and 40 (see Photo 1). Connect every pin except pin 13 to the corresponding pin of the chip below. You can solder directly to the chip or, better yet, solder a 16-pin socket to the lower chip and plug in the piggyback chip with pin 13 sticking out to the side. Slip a Molex socket pin on each pin 13 and tie all of these together using fine insulated wire. Connect the other end of this wire to MIC 23 pin 11.

8. Take GIC 11, 12, 13 and 14 and carefully bend every pin, except power and ground, straight out. Piggyback these to the following chips.

GIC 11 to MIC 19

GIC 12 to MIC 18

GIC 13 to MIC 20

GIC 14 to MIC 24

Form the leads slightly on GIC 12 and 13 so that the 14-pin package will fit the 16-pin spacing. Use a small hot iron to ensure a good solder joint.

9. Wire up the auxiliary board. Don't forget to tie the unused inputs on the counters and flip-flops to +5 using 1k pull-up resistors. Wire the connections to the TVT-II to the edge connector on the prototyping board. Wire up a mating female connector with the wires coming from the TVT-II. Connect power and ground to the auxiliary board. (Fig. 5 is a component legend for Photo 2 —the auxiliary board and the memory board.)

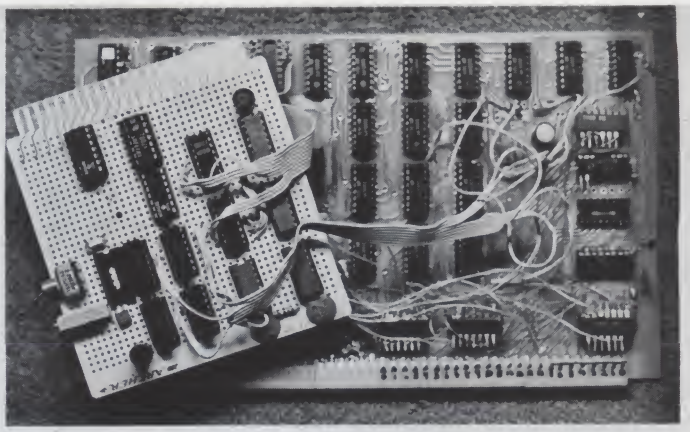


Photo 2. The graphics board unmounted showing the ribbon cables for address and data. The trimpot and empty socket remain from previous versions and are omitted from the present design. The single 2-56 mounting screw is visible just below the small can capacitor to the right of the memory board.

10. Wire the address decoder, write pulse, and transceiver control circuitry. Connections to the outstretched IC pins are best made by hand wire-wrap.

11. Connect GIC 13 pin 8 to MIC 7 pin 3 and GIC 13 pin 6 to MIC 36 pin 3. This will supply write pulses to all 40 RAM chips.

12. Use ribbon cable for the address and data lines running between auxiliary and memory boards. A convenient way to connect A0 to A9 is to piggyback onto any RAM chip using a 16-pin socket and header.

13. Mount the auxiliary board to the memory board using a ¾ inch 2-56 bolt. This will require drilling a 3/32 inch hole just below and slightly to the right of C1 when viewed from the bottom side. Make sure that the screw head will not contact any traces.

14. Check and double-check your work for wiring errors, solder bridges, reversed ICs, etc.

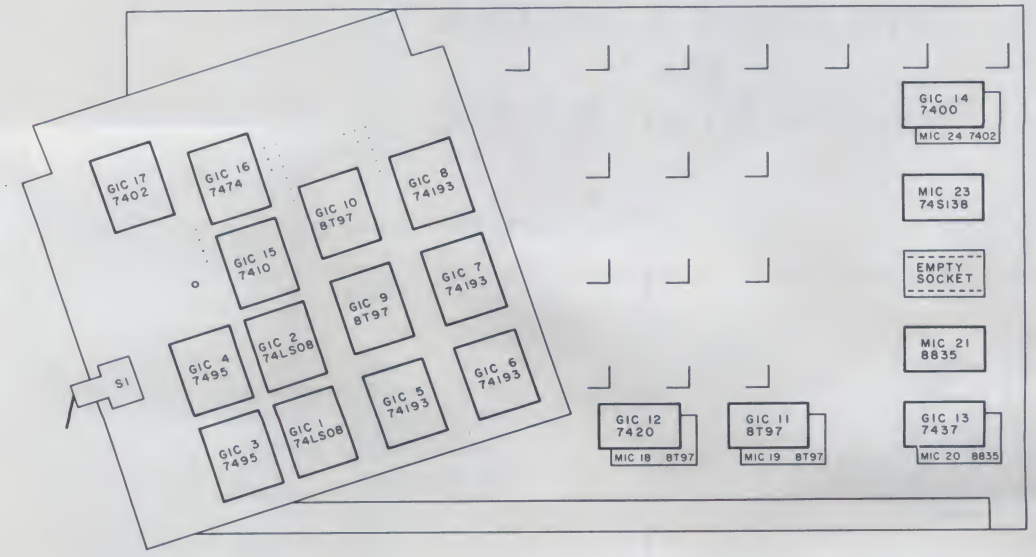


Fig. 5. Component layout for Photo 2.

System Checkout

With luck, your graphics system should be functional. Plug the assembly into the motherboard, connect to the TVT-II, set S1 for 6000-73FF, set S2 for BOTH and power up. You should see a pseudorandom pattern of start-up garbage on the screen. Switching S2 should display TVT-II, graphics or both.

Using MIKBUG, enter 01 into location 6000. This should put a single dot in the upper left corner. Entering 80 into 73FF should draw a single dot at the lower right corner. Clear this block of memory using a routine like ERASER (see *Part 2* of article) and repeat the above, making sure that no other locations are altered.

If you've gotten this far, try running some memory diagnostics. This block should act like any ordinary memory. If everything works put away your scope and start drawing pictures. If you're having trouble, the most likely fault is a wiring error. Go back and check all your connections again. If you can't find anything, have a

friend check them too.

Listing all of the possible fault modes would be impossible. Using common sense and a scope to narrow the problem to successively smaller portions of the circuitry should locate the problem, however. Check power and ground for each IC at its pins—not just at the socket pin. Check that GIC 12 is producing appropriate MPU enable (active low) pulses during MPU accesses and that the two sets of buffers aren't enabled at the same time.

Scope the Tri-stated address lines to check that the counters and buffers are generating addresses. Check that data are entering and leaving GIC 1 and 2 and are being shifted out of the shift registers. If nothing is getting out of GIC 1 and 2, then look for problems in blanking or blanking pulse generation. A good TTL VIDEO signal, but bad picture, implies a problem in the video selector circuit.

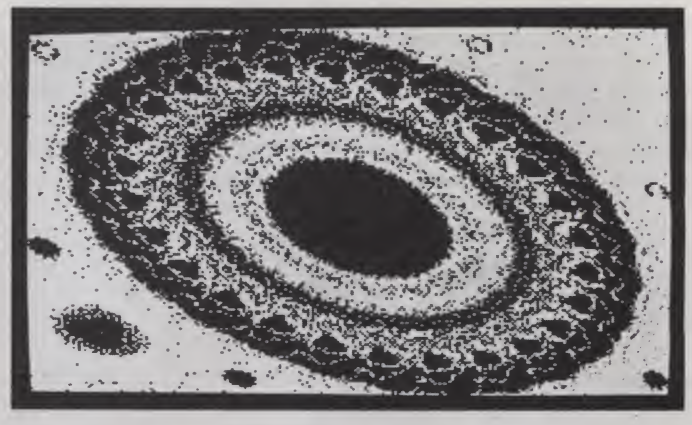
Miscellaneous Notes

1. Keep the leads connecting the TVT-II to the graphics board as short as possible to minimize noise pickup and radiation. You may want to use shielded cable for each signal line. Do not use multiconductor shielded cable as the tightly bound wires will cross-couple.

2. The $\overline{\text{LINECNT RESET}}$ input is the signal most susceptible to noise. The reset pulse is less than 100 nanoseconds wide and occurs only once every 16 milliseconds. I inverted it going onto the graphics board to make it active low rather than active high. TTL idling at a high level rejects noise better than at a low level. For stubborn cases (evident as tearing and jumping of the lower part of the picture), try shielding this signal or adding a 1k pull-up resistor to +5 on the graphics board. As a last resort you may want to try a line driver and receiver pair such as the 1488/1489 biased to −12 volts. I have had good results simply inverting to active low.

3. If you run memory diagnostics on this block of memory, remember one point—the additional RAM chips are addressed as quadrant 1 chips (really quadrant 5), but are physically mounted in quadrant 3 positions. Therefore, you should use the quadrant 3 map to track down bad bits in the new chips. Refer to the table on page 7 of the MP-M assembly instructions.

4. Do not substitute a 7408 for the 74LS08 (GIC 1,2). These gates are connected directly to the 2102L1 Data Out lines, which are guaranteed for only one TTL load. Since they are already driving that load (the 8835 driver inputs), an additional TTL load would exceed the specs and result in a noisy display. Low power Schottky, being ¼ of a standard TTL load, works well, even though the combined load technically exceeds specs by several hundred microamperes worst case. ■



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Robert L. Kurtz W6PRO
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Rolling Hills CA 90274

World of the Brass Pounders: Receive Morse Code the Easy Way

Microcomputing and amateur radio make an exciting combination, if you haven't already discovered it. This Morse code reader is an excellent example of what we mean.

A great feature of a personal-computing hobby is that it can be used to work with other hobbies. A case in point is this little program to decode and print out Morse code. I originally wrote this in machine language for my KIM system, where it took up less than one page, and finally decided to try it in BASIC.

Even though the program looks simple, it has some unusual surprises, such as self-adaptive adjustment for changes in code speed. In addition, the influence of changes in dash or dot length is weighted so that they must occur five or six times in succession before the computer decides that there has been a bona fide speed change. As a result, an occasional "bad" character will not mess up your copy; the printout is extremely stable and the copy is relatively foolproof.

```
1 REM MORSE CODE READER - WRITTEN BY R. KURTZ - W6PR0
2 RESTORE
3 PRINT CHR$(26):REM CAN DELETE - PUTS CURSOR AT TOP OF PAGE
5 DIM A$(100)
6 FOR N=1 TO 100:READ A$(N):NEXT N
10 A=PEEK(5888) AND 1
11 IF A=1 THEN 10
15 B=0
20 A=PEEK(5888) AND 1:B=B+10
30 IF A=1 THEN C=((5*C)+(2*B))/6:DO=2*DO:DA=2*DA:DO=DO+1:GOTO 100
40 IF B<(.5*C) THEN 20
50 DO=2*DO:DA=2*DA:DA=DA+1
60 A=PEEK(5888) AND 1:B=B+10
70 IF A=0 THEN GOTO 60
80 C=((4*C)+B)/5
100 B=0
110 A=PEEK(5888) AND 1
111 B=B+10
120 IF A=0 THEN GOTO 15
130 IF B<(.5*C) THEN GOTO 110
140 GOSUB 300
150 A=PEEK(5888) AND 1
151 B=B+10
160 IF A=0 THEN GOTO 15
170 IF B<(2*C) THEN GOTO 150
180 PRINT " ";
190 GOTO 10
300 DA=DA*2
310 D=DA+DO
330 IF D>100 THEN D=100
340 PRINT A$(D);
350 DA=0:DO=0
360 RETURN
400 DATA E,T,I,A,N,M,S,U,R,W,D,K,G,O,H,V,F,-,L,-,P,J,B,X,C
410 DATA Y,Z,Q,-,-,5,4,-,3,-,-,-,2,-,-,-,-,-,-,-,1,6,-,/,-
420 DATA -,-,-,-,7,-,-,-,8,-,9,0,-,-,-,-,-,-,-,-,-,-,-,-,?
430 DATA -,-,-,-,-,-,-,-,.,-,-,-,-,-,-,-,-,-,-,-,-,-,-,-,-
```

Program listing.

The program also detects the end of the word and prints out a space, if required.

The program's memory needs are minor—just a little over 1K of RAM is required. The program is written in Microsoft BASIC on the KIM computer, but should operate with any relatively fast BASIC. From a hardware standpoint, if your CRT or printer will go to 300 baud, this program will provide excellent copy of Morse code, up to 15 or 20 words per minute. If your terminal operates up to 1200 baud, it will follow the Morse transmissions to well over 30 words per minute.

Loading the Program

Input the program exactly as written, even though some of the instructions may seem redundant. It is written this way to save operating time—a very important consideration when you are dealing with fast-acting dots and dashes.

Lines 10, 20, 60, 110 and 150 instruct a PEEK to location 5888 (decimal). In the KIM computer, this is a peripheral input address at 1700 (hex). This location reads a total of eight input ports as an eight-bit word.

The AND 1 on lines 10, 20, 60, 110 and 150 assures that the computer is only reading the port to which the incoming Morse is connected. Obviously,

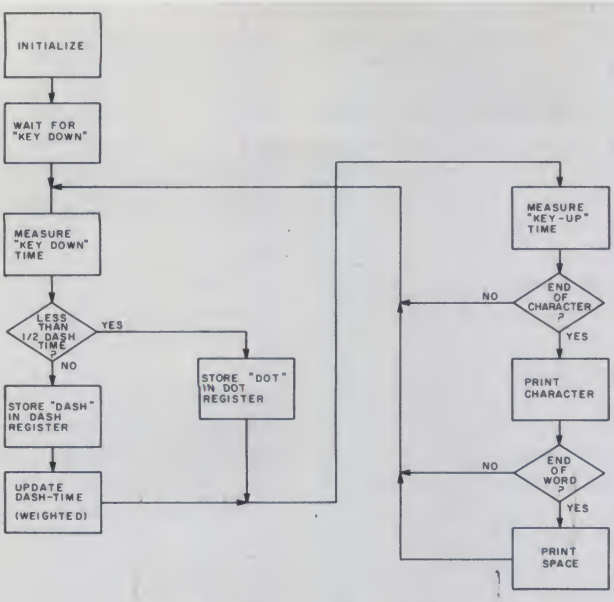


Fig. 1. Simplified flow diagram.

EXAMPLE: D = — ● ●

Initial conditions: Dot register = 0, Dash register = 0.

First period: Input a dash.
- 2 times dash register = 2 x 0 = 0.
- 2 times dot register = 2 x 0 = 0.
- Add 1 to dash register = 1 + 0 = 1.
- Summary: dash register = 1, dot register = 0.

Second period: Input a dot.
- 2 times dash register = 2 x 1 = 2.
- 2 times dot register = 2 x 0 = 0.
- Add 1 to dot register = 1 + 0 = 1.
- Summary: dash register = 2, dot register = 1

Third period: Input a dot.
- 2 times dash register = 2 x 2 = 4.
- 2 times dot register = 2 x 1 = 2.
- Add 1 to dot register = 1 + 2 = 3.
- Summary: dash register = 4, dot register = 3.

End of Character—determine lookup number for D.
- 2 times dash register = 2 x 4 = 8.
- Add dot register and dash register = 8 + 3 = 11.

Answer: D = 11.

Example 1.

this must be changed to fit your particular system.

In addition, the program assumes that when a dot or a dash occurs, a logic 0 appears on the input port. This is in agreement with a "key down" shorting the input port to ground, and also in agreement with the hardware interface circuit described later. If your hookup provides a logic 1 during a dot and a dash, then lines 11, 30, 70, 120 and 160 must be changed so that all IF A=1 statements should read IF A=0, and vice versa.

Program Description

Fig. 1 is a simplified flow diagram of the program. The initialization routine (lines 1 through 6) sets the lookup table that will permit the printout of the proper character. The program then waits for a key down to occur (lines 10 and 11). The first part of the operating program (lines 20 through 80) measures the length of time that the key is down and compares this with the stored value for the length of a dash.

If the key is raised in less than one-half of the stored dash time, the computer writes a dot into the dot register (line 30) and goes to the second part of the operating program.

If the key remains down longer than one-half of the dash time, a dash is stored in the dash register (line 50), and the value of the dash time is updated with a one-to-four weighting (line 80). This is accomplished by multiplying the old value of the dash time by four, adding the new value, and then dividing by five. As a result, the stored value of the dash time cannot change drastically from character to character, and the copy is not susceptible to errors from erratic sending habits.

The second part of the program (lines 100 through 190) measures the length of time the key is up. If it's up less than one-half of the dash length, the program assumes that the character is not complete and no printout is provided (see lines 100 through 130). If the key is up longer, the program jumps to line 300, the print-character subroutine. If the key is up longer than twice the dash length, the program assumes that a word is complete and a "space" is printed (lines 170 and 180).

1. If the input signal is a dash:
   - A. Double the values in the dot and dash registers.
   - B. Add 1 to the dash register (see line 50).
2. If the input signal is a dot:
   - A. Double the values in the dot and dash registers.
   - B. Add 1 to the dot register (see line 30).
3. If the character is complete:
   - A. Double the value in the dash register.
   - B. Add the dash and dot registers to obtain the lookup number.
   - C. Clear the dot and dash registers.

Table 1.

Lookup Table

The heart of the program is the algorithm that counts the dots and dashes and develops a number used to look up the actual character to be printed. In other words, each combination of dots and dashes in Morse code has a discrete number that commands a given character to be printed. This algorithm has three conditions as listed in Table 1.

Steps 1 and 2 keep repeating until the character is complete. When the program detects a key-up period longer than one-half of a dash length, it is assumed that the character is *complete and step* 3 is accomplished (lines 300 to 430). The manner in which the *lookup* number for the letter D is

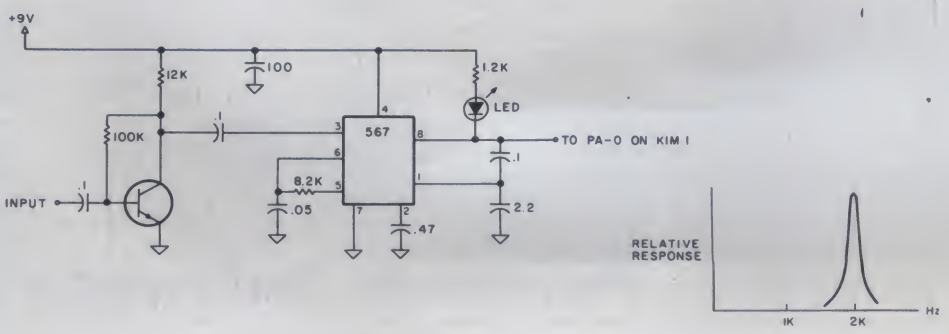


Fig. 2. Interface circuit.

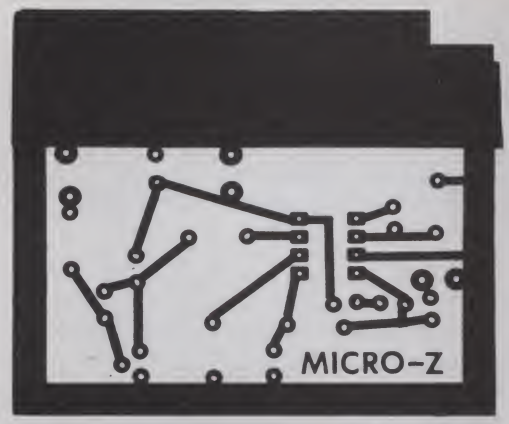


Fig. 3. Circuit board.

formed is shown in Example 1.

Interface Hardware

Fig. 2 shows a typical circuit for connecting your radio receiver to the computer. The NPN transistor is an R/C coupled audio amplifier connected to a type 567 phase-lock loop circuit. The free-running frequency of the phase-lock loop is set by the values of the capacitor and resistor connected to pins 5 and 6 of the 567, and is approximately 2000 Hz. The capacitors on pins 1 and 2 of the PLL adjust the bandwidth to about 100 Hz, and the LED serves as a tuning indicator—that is, it will start blinking when the signal is in the center of this narrow bandpass.

This circuit is compatible with the program, as written, in that the output signal goes to a logic 0 when a dot or a dash occurs. The circuit shown is not my original idea, but has appeared in numerous publications; you may have your own favorite circuit that you would like to use. As long as you maintain the same output logic (a 0 for a dot or dash), there will be no problem.

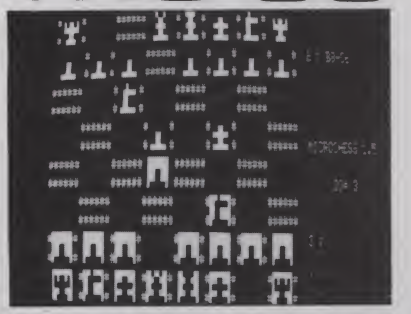
Incidentally, the circuit has another unique application. Since it is only activated by audio signals over a fairly narrow band, it can also be used to key an audio oscillator set to any frequency desired. When Morse CW comes in amidst a jumble of other signals, the phase-lock loop picks out the signal you want and keys the audio oscillator . . . and that is all you hear. A full-scale outline of the circuit board is shown in Fig. 3.

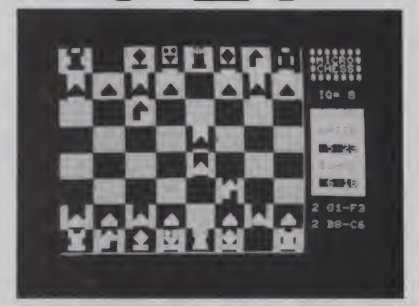
Adjusting the Program

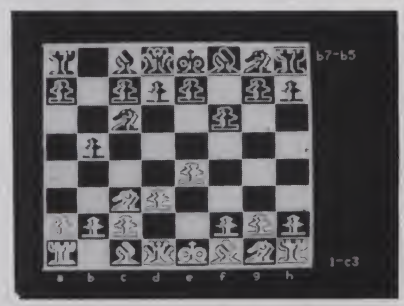
One of the advantages of writing this program in BASIC is the ease with which the computation constants can be changed. For instance, you may wish to experiment with different algorithms to detect whether a key-down signal is a a dot or a dash . . . to take care of "swing-fisters." This can be accomplished easily by changing the factor in line 40 from (.5*C) to (.25*C) or (.75*C). By the same token, the constants in lines 111 and 151 can be changed to provide more leeway for the formation of characters and spaces.

One final note for KIM users: The 9K Microsoft BASIC is excellent and may be obtained from Micro-Z Co., Box 2426, Rolling Hills CA, for $100. In addition, a full kit of parts for the interface circuit, circuit board, Morse-code reader listings in both BASIC and machine language, and instructions on how to connect it to an audio oscillator are available from Micro-Z Co. for $16.50 postpaid. ■

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Parallel and Serial I/O Ports

This is the second session we'll devote to discussing computer input-output.

Peter A. Stark
PO Box 209
Mt. Kisco NY 10549

In the last session, we started our look at computer input and output by examining single inputs and outputs, EIA levels and current-loop interfaces. This month we continue with our discussion of parallel and serial I/O ports.

The ASCII Code

Since popular personal computers work on eight-bit bytes, data can also go in groups of eight lines. A group of eight lines used for simultaneous input is then called a parallel input port; eight output lines are called a parallel output port. Although the eight bits can stand for just some eight-bit binary number, often they stand for a coded alphanumeric character.

There are various ways to code these characters, but the most common and most popular is to use a code called ASCII, the American Standard Code for Information Interchange. In this code, there is a specific bit pattern for each letter, number or punctuation mark. For instance, the letter A has the pattern 1000001; the number 5 has the pattern 0110101; a space is a 0100000. Although we could make up a long conversion table giving the codes and the characters they stand for, most often this is presented in the compact form shown in Fig. 1.

Here we see the 128 possible characters that can be made up out of seven bits drawn in the form of a table. For any given character, we look up the first three bits of its code at the top of the table and the last four bits at the left. For instance, for the letter A we see that the leftmost three bits are 100, and the rightmost four are 0001, so the complete code is 1000001.

This table shows the ASCII codes not only for the capital letters, numbers and common punctuation marks in the center columns, but also for the lowercase letters and a few other unusual punctuation marks at the right, and some special control characters at the left. These control characters are abbreviated in the table—for instance, NUL means null or empty, STX means start of transmission, LF is line feed, etc.

At this point you may have noticed that we talked of eight-bit characters, yet this table only gives seven-bit codes. ASCII is really only a seven-bit code, but an eighth bit called a parity bit is often added to it. This added bit is used for detecting errors in sending the character from one place to another and is often removed inside the computer.

When parity is used, then for any given character the parity bit may be either a 0 or a 1, depending on what other bits there are in the code. If even parity is used, then each character code will always have an even number of ones. That means that if the seven-bit code already has an even number of ones in it, then the parity bit will have to be a 0 to keep the number of ones even.

On the other hand, if the seven-bit code has an odd number of ones, then the parity bit will be a one, so that the total number of ones will be even. (In odd parity, the opposite would be true.) As an example, the seven-bit code for the letter A is 1000001. With the parity bit at the left, in even parity the com-

LEFTMOST 3 BITS

RIGHTMOST FOUR BITS	000	001	010	011	100	101	110	111
0000	NUL	DLE	SP	0	@	P	`	p
0001	SOH	DC1	!	1	A	Q	a	q
0010	STX	DC2	"	2	B	R	b	r
0011	ETX	DC3	#	3	C	S	c	s
0100	EOT	DC4	$	4	D	T	d	t
0101	ENQ	NAK	%	5	E	U	e	u
0110	ACK	SYN	&	6	F	V	f	v
0111	BEL	ETB	'	7	G	W	g	w
1000	BS	CAN	(	8	H	X	h	x
1001	HT	EM	)	9	I	Y	i	y
1010	LF	SUB	*	:	J	Z	j	z
1011	VT	ESC	+	;	K	[	k	{
1100	FF	FS	,	<	L	\	l	¦
1101	CR	GS	-	=	M	]	m	}
1110	SO	RS	.	>	N	^	n	~
1111	SI	US	/	?	O	_	o	DEL

Fig. 1. The ASCII code.

plete eight-bit character would be 01000001, while in odd parity the complete code would be 11000001.

In many computer systems the parity bit is not used, but a full eight bits are still used for each character. In that case, the parity bit will always be the same (a 0 or a 1) regardless of whether the total number of ones is odd or even.

A good place to see ASCII coding is in punched paper tape. Fig. 2 shows a short piece of tape. To guide the tape through a tape reader and to provide timing marks so the tape will move at a constant speed, it has a row of small holes punched the entire length of the tape. These are called sprocket holes, just like those on camera film. As shown in the figure, there is space for five other rows of holes to the left of the sprocket holes, and three to the right. A character is punched as a set of holes going across the tape. Each group of holes going across the tape is called a frame.

If you look at the sample tape in Fig. 2, you will see that every frame has an even number of holes—either 2, 4 or 6. Thus this tape was prepared with even parity.

If you observe the notes on Fig. 2 and read from top to bottom, you can actually read the punches on the tape by referring to the ASCII code in Fig. 1. Hint: at the bottom, just before the CR (carriage return) and LF (line feed) is the date 02/11/77.

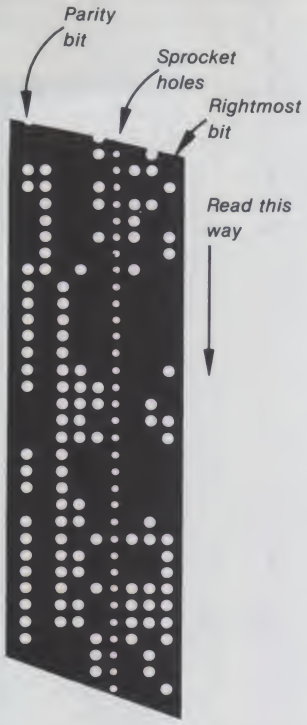


Fig. 2. Punched paper tape in ASCII.

Experiment #63
Parallel Port Handshaking

Problem: Suppose an eight-bit parallel port is used to send a character from a computer to a printer. How does the printer know when a new character is coming, and how does the computer know whether the printer has received it?

Solution: This is done with a few additional lines for handshaking. Actually, handshaking is usually needed for both input and output.

Theory: Fig. 3 shows the overall block diagram of how the computer might connect to an output device such as a printer. At the top we have the eight parallel data lines, which carry the ASCII character (though sometimes it might be only seven or even six lines) coming from the computer's output port. In addition to these data lines, we show three more lines, called handshaking lines.

When the computer has a character to send out, it puts it on the data lines and then sends out a DATA READY signal to the printer. This informs the printer that there is a character waiting. If the printer has some sort of a holding register (a group of flip-flops) that will hold the character until it can be printed, then the computer will simply hold the character there for some specified amount of time before removing it.

But if for some reason the output device is slow, then it might be better if the computer keeps sending out the character until some signal comes back saying that the character has been accepted. This is the function for the DATA ACCEPTED line.

Once the printer has the character, it can start printing it. This is usually a slow operation, and the computer should not send out the next character until the printer has finished the present one. In other words, the printer should send back a READY signal when it's ready for more data.

As shown in Fig. 3, we have three handshaking lines. Sometimes we can make do with just two (one each way), and other times we may need more. But this gives a good example of a basic setup.

Procedure: For this experiment, we will try a handshaking circuit that might be used with a reader for paper tape.

Most professional tape readers have some kind of motor or ratchet arrangement for moving the tape. This complicates the system, so let's just talk about one of the simple readers that needs a human hand to pull the tape through.

As shown in Fig. 2, punched paper tape has room for nine holes across the tape—eight data holes and one sprocket hole. So we need a way of reading the nine holes. We could probably come up with some mechanical way of reading them—metal fingers poking through the holes or a toothed wheel riding over them or something equally extravagant—or simply try a photo-detector sensing the light shining through the holes. Since we've already experimented with a photo-transistor, that seems like a good way to go.

The holes in the tape are spaced about 0.1 inch apart, so we need a photo-transistor small enough that nine of them can be stacked in a row, with 0.1 inch spacing between them. This is difficult to do, but fortunately several manufacturers make photo-detector arrays intended for this purpose. There are nine detectors in one package, spaced the right distance apart. So that's no problem. (Remember—this is a computer course, not a paper-tape reader course. So let's not go into too much detail here.)

Fig. 4 shows how we might build such a simple tape reader. Starting with a photo-transistor array, we connect each of the nine transistors to a pull-up resistor to +5 volts and also to some device that will convert a slowly varying output voltage into a nice square pulse. A 7413 Schmitt trigger is a good choice, since this is a type of NAND gate that has a very sharp switching point in the output as the input slowly varies. (The zigzag symbol inside the NAND means Schmitt. If you don't remember them, review Experiment #42 on Schmitt triggers.) Another possibility is a 555 timer connected as a Schmitt.

When a photo-transistor is dark (no hole), its resistance is high, and so the Schmitt trigger gets a positive input voltage. Since the 7413 inverts, the output will be near 0 volts, or a digit 0. But when there is a hole, the output will be positive, or a digit 1.

Of the nine photo-transistors, the top five and the bottom three provide the eight data bits to the input port. But the fourth from the bottom senses the sprocket hole and has to be treated differently.

The output of the sprocket Schmitt trigger is sent to the clock pulse input on a flip-flop. The 7474 is a good choice here, since it will trigger when a hole

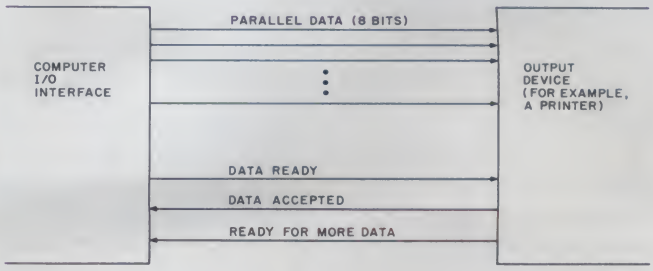


Fig. 3. Typical handshaking for an output device.

is sensed, and the 7413 output goes high. Since the D input of the flip-flop is connected to +5 volts, the 7474 will set each time a sprocket hole is sensed.

As you remember, the sprocket holes are smaller than the data holes. Therefore, the data holes will arrive at the photo-transistor first, and the eight data bits will already be present by the time the sprocket hole is sensed. So the reader first generates the data and then sets the 7474.

The Q output of the 7474 is sent to the computer as a DATA READY signal. When the computer senses the DATA READY, it reads the incoming data from the input port and then sends back a DATA ACCEPTED signal, which resets the flip-flop. As shown in Fig. 4, this would have to be a low signal to reset the flip-flop, but by adding an inverter in the reader we could use a high signal instead. In any case, as soon as the data is read by the computer, it sends back a DATA ACCEPTED, which clears the flip-flop and turns off the DATA READY. This is important, because if the DATA READY signal stayed on, the computer might think it was a new character and read in the same character several times.

As you can suspect, with proper handshaking, parallel data transmission can be fast. Characters can be sent as fast as they can be generated or received. Parallel data transmission is always used with fast I/O equipment, such as disks, fast line printers, multitrack computer tapes and so on. But to go at its maximum speed, parallel data needs at least two handshaking lines in addition to the data lines, for a total of eight lines.

Experiment #64
Asynchronous ASCII Data

Problem: If you don't need the speed, can you send eight-bit ASCII data on fewer lines to save some money?

Solution: Obviously yes, or else we wouldn't have brought it up. Instead of parallel data, we send it in serial form. That is, we send the eight bits on one wire, but only one bit at a time.

Theory: If we send the bits separately but on one line, then the receiver at the destination has to know which bit is which. We could do this by setting up several handshaking lines to tell the receiver when the group of eight bits starts and when it ends. But this somehow seems to defeat the whole purpose—we are trying, after all, to cut down the total number of lines.

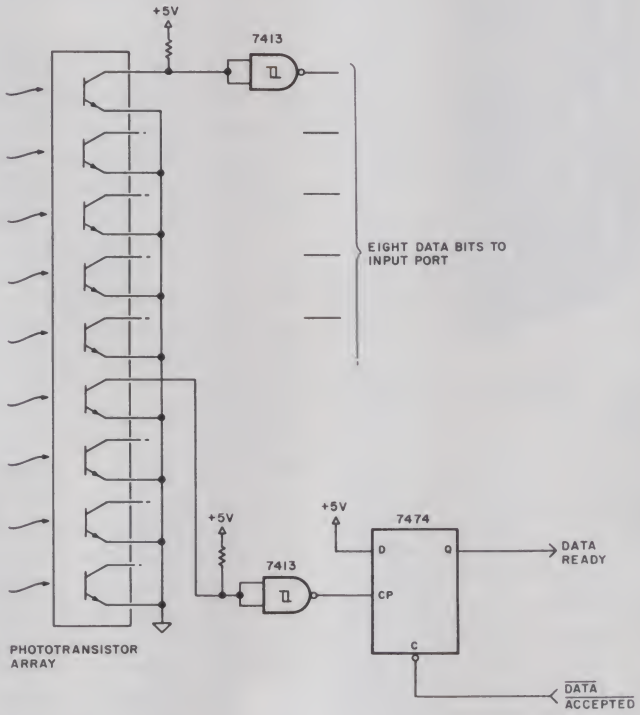


Fig. 4. Logic diagram of a simple paper-tape reader.

So we put all this additional information on the same data line as will carry the data bits. This is done by agreeing on a very carefully timed sequence as shown in Fig. 5.

First, we agree that the characters to be sent may come together in bunches or may be separated by unknown and random intervals of time. But once a character starts, its timing will be precisely controlled, with each bit lasting a known length of time. Since the characters can arrive at unpredictable times, we need to decide what will be on the line between them. As shown in Fig. 5, this is a 1 level, which lasts up until the very beginning of the character.

Let's define some of the words used to describe this kind of serial transmission. Since the characters can arrive at random times, they are not synchronized with any clock pulses. Hence this is called asynchronous data; sometimes it is also called "start-stop telegraphy" because it dates back to the days when teleprinters first started to replace hand-sent Morse code.

Just before Morse code started to be phased out in land-based telegraph service, they tried to record the Morse code on paper tape by letting a pen make a mark when current was flowing through the wire during a dot or dash. Between the marks there was a space, produced when there was no current in the telegraph wire. In modern current-loop teleprinter circuits a current flow is a 1, and an absence of current is a 0; but the old words mark and space have still persisted, and so we often call the 1 a mark and the 0 a space. In other words, between characters there is a steady mark level (a 1) on the line.

At the beginning of a new character, the signal suddenly changes to a space (0) to form the start pulse shown in Fig. 5. Starting with this pulse, we have a string of either 10 or 11 bits, which follow at a precise speed. This consists of the start bit, eight data bits, which carry the ASCII character and its parity bit, and either one or two stop bits.

As you can see in Fig. 5, the start bit is always a 0 or space, the eight data bits can be either 0 or 1, depending on the character code, and the stop bit is always a 1 or mark. If the character is immediately followed by another one, then the next start bit will be right after the end of the stop. If not, then the stop will simply be continued at a 1 (mark) level until the next character comes along.

Fig. 5 also shows that the bits are sent backward. For instance, the code for the letter E is 1000101. Assuming odd parity, the parity bit would be a 0, and so the complete eight-bit code would be 01000101. But when sent over an asynchronous line, the bits would be sent backward as 10100010 as shown. The reason is that it is convenient if the parity bit is sent last, so that it can be checked after the rest of the bits are received.

The bit timing has to be very precise once the start bit starts. Standard speed for a typical model 33 Teletype of the type that is often used with computers is 110 bits per second. This makes each bit last exactly 1/110 second, or 9.09 milliseconds. The 110 bit-per-second rate is only a maximum, reached when characters are sent continuously. Obviously when there is a large space between characters, the number of bits per second might go as low as zero if the characters come every half hour or so. But the time for each bit is still 1/110 second, and the system is still called a 110 bit-per-second system. The word baud is often incorrectly used instead of bit per second, and so this is often called 110 baud transmission.

Other popular baud rates are 150, 300, 600, 1200, 2400, 4800 and 9600. You can find the time

per bit by dividing the baud rate into 1. Thus at 300 baud each bit lasts 1/300 second, or 3.33 milliseconds.

The speed of 110 baud is usually only used with mechanical Teletype machines; if an electronic CRT terminal is used, then more often a higher speed such as 300 baud or even faster is used. This concept is important because it also determines the number of stop bits.

In a Teletype machine, a clutch disables a rotating shaft at the end of each character. In order to give this clutch enough time to operate, there must be an extra few milliseconds between characters. Hence at 110 baud, the speed used by mechanical Teletypes, there are always two stop bits used to give this extra time. At higher speeds, however, only one stop bit is usually used.

From this information you can figure out how many characters can be sent per second. At 110 baud, each character requires 11 bits (one start, eight data and two stop bits), so that we can send a maximum of 10 characters per second. This happens to be the maximum speed of a model 33 Teletype. At 300 baud, on the other hand, we need only 10 bits per character (one start, eight data and one stop bit), so we can send up to 30 characters per second.

Unless you have an oscilloscope, there is no easy way to observe asynchronous data at 110 baud or faster. But we can still generate it at a slower rate and observe it on an LED or on a meter. There are two ways of doing this—with a multiplexer or with a shift register.

Fig. 6 shows a circuit that could be used to generate asynchronous data with a multiplexer. It uses circuits you've already seen: the 555 timer, which is being used to generate a clock signal, was already covered in Experiment #12; the 74150 multiplexer was covered in Experiment #44; and the 7493 is similar to the binary counter you built with 7473 flip-flops in Experiment #50. Since it's been almost a year since you did those experiments, you may want to go back over them to review these ICs.

We're not really going to build this circuit, but it's a good one to discuss anyway. Suppose that initially the switch between the 555 clock and the 7493 counter is open, so that

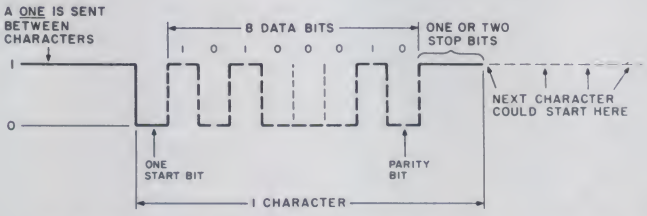


Fig. 5. The letter E as sent over a serial asynchronous line.

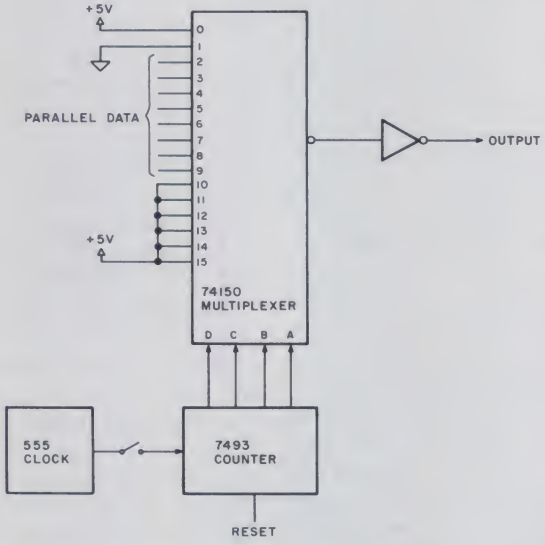


Fig. 6. Generating asynchronous data with a multiplexer.

the counter is getting no input. Assume also that by putting a pulse on the counter's reset input we've reset it back to a count of 0000, which is therefore being sent over to the 74150 multiplexer.

The multiplexer selects the 0 input, which is connected to +5 volts, and sends it to the output. Actually, the 74150 does a built-in inversion, and so the output signal is grounded, rather than at a high level. But the inverter connected to the output inverts it back into a high or 1. Thus the asynchronous output is normally a 1 or mark level between characters.

Now let's connect an eight-bit ASCII character to inputs 2 through 9 of the multiplexer, with the rightmost bit going to the number 2 input and the leftmost, or parity, bit going to the number 9 input. Since the multiplexer is still set to input 0, nothing will happen at the output.

But now close the switch between the 555 clock and the 7493 counter. As clock pulses start arriving at the counter, the counter will start counting up in binary: 0001, 0010, 0011 and so on. Each count is being sent to the multiplexer, and so the multiplexer starts scanning its inputs, going down the line from input 1 down to 15.

First, it samples input 1, which is grounded, and so the output of the multiplexer is a 1; therefore, the inverter sends out a 0. This is the start pulse.

Then, in turn, it samples each bit of the parallel data, one bit at a time, starting with the rightmost digit of the ASCII code and ending with the parity bit. After that, it reaches the six inputs connected to +5 volts, and this is a 1 output, which is a very long stop pulse.

Since the counter is a binary counter that counts to 15, it samples all the inputs. If we use a counter that only counts to 11, then we will only get two ones at the end.

This is a very useful circuit, since if we just jumper the parallel data inputs to ground or +5 volts, we can use this as a test-signal generator to generate a continuous string of characters. But in a computer system it is not very practical since it requires some sort of a holding register to hold the eight-bit ASCII code during all the time that it is being sent out by the multiplexer. This requires eight flip-flops in addition to the multiplexer, whereas with the right circuit we can make do with just the flip-flops. Still, it is an interesting circuit to study.

That brings us to the shift-register approach. In the shift register, we have a group of flip-flops that can be loaded in parallel from the computer with the ASCII character. But then, after being loaded, it can shift them out the end, one by one, in serial.

Procedure: The first thing we need is a shift register that can be loaded in parallel. In Experiment #46 you already built a shift register using 7474 dual D flip-flops. In case you don't remember, the circuit had all the flip-flop clock inputs connected together, and the Q output of each flip-flop was connected to the D input of the next flip-flop to the right.

A shift register can also be built *from 7473 or 7476* flip-flops. Fig. 7 shows the circuit for the 7476 dual J-K flip-flops. Notice how the J and K inputs of each flip-flop are connected.

The leftmost flip-flop has its J input connected to +5 volts and the K input to ground. Thus when a clock pulse arrives, this flip-flop will set. Each of the other flip-flops is connected to the one to its left, so that when a clock pulse arrives, a bit in one flip-flop will move right into the next one. This is how the shifting is done to the right; eventually the number in the shift register will shift com-

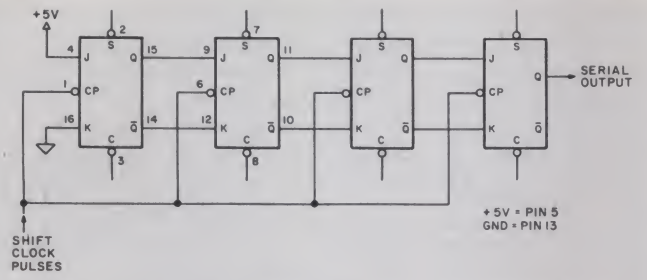


Fig. 7. Building a shift register out of 7476 dual J-K flip-flops.

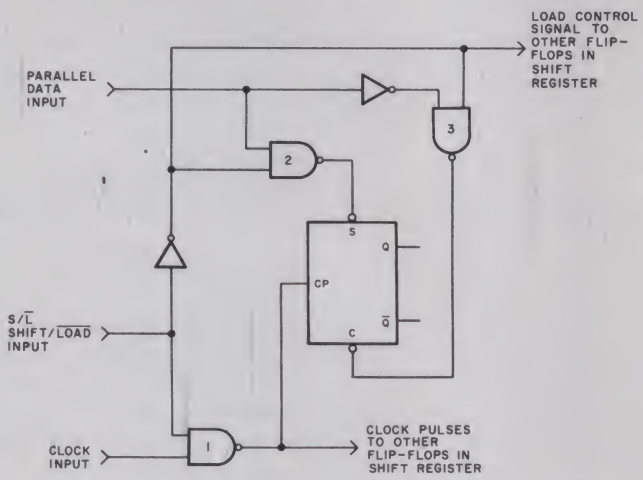


Fig. 8 A 7476 flip-flop wired as a presettable shift register.

pletely out the right end.

To output eight-bit characters, we really need ten flip-flops: The first one will generate the steady 1 or mark signal, the second will generate the start pulse and the next eight will generate the ASCII data. We don't need any flip-flops for the stop bits, since we have the leftmost flip-flop connected so that it will shift a 1 into itself at each clock pulse.

Unless you have a good supply of 7473, 7474 or 7476 ICs, you probably will not be able to build such a long shift register. Save one 7473 or 7476 for later and build as much of a shift register as you can with the rest.

Our next problem is to connect these flip-flops so they can be simultaneously loaded from a parallel port. The easiest way to do it on your breadboard is with jumper wire, which you use to ground the set and clear inputs of the flip-flops to set or clear them. This is convenient with the 7474 and 7476 flip-flops, which have both set (preset) and clear (preclear) inputs; with the 7473 it is a little tougher since it only has the clear input. But if you remember that a 1 is shifted into the register from the left, you realize that after the first character is sent, all the flip-flops will already be set, and therefore it is only necessary to clear the ones that should contain a 0.

In real life, though, you can't expect somebody to sit there with a wire jumper, setting and resetting flip-flops. There has to be a circuit to load them with the required parallel data when needed. Fig. 8 is a good example. Fig. 8 shows the circuit for just one flip-flop of the shift register; parts would have to be duplicated for each of the other flip-flops.

The shift register now has a control input labeled shift/load. When this control signal is high, the register shifts. When it is low, it loads the parallel data.

Let's start looking at Fig. 8 with the shift/load input assumed high. This enables gate 1 so that the clock input can get to the CP (clock pulse) input of this flip-flop and all others in the register. At the same time, the shift/load signal is inverted into a low and sent to gates 2 and 3, which therefore are turned off and provide a high output. This does nothing, since both the set and clear input of the flip-flop require low signal (that is what is meant by the small circle on the input). So with the shift/load input high, the register just shifts.

But let's suppose that the shift/load control input goes low. Now gate 1 is turned off since one of its inputs is a low, and therefore no flip-flop can get a clock pulse. So shifting stops. At the same time, the shift/load is inverted into a high and applied to gates 2 and 3, which are therefore enabled

Notice now that the parallel data input is applied directly to gate 2 and through an inverter to gate 3. One of these will therefore get a high level and the other a low level. If the parallel data input is a high or 1, gate 2 will have a low output and set the flip-flop, while gate 3 will have a high output and do nothing. But if the parallel data input is a 0, then the flip-flop will reset.

If the parallel data changes while the shift/load signal is low, then the flip-flop will also change. But once the shift/load goes high, the flip-flop will stay in whatever state it was in last, and then the entire register will start shifting.

This happens to be a very popular circuit, since parallel-to-serial data conversion is very common. In fact, there is a presettable eight-stage shift register IC, the 74165, which has eight flip-flops and all of the circuitry to parallel load them or shift. The pin-out of the 74165 is shown in Fig. 9. It works exactly like the circuit we just described for Fig. 8, and the shift/load circuit has the same form.

To generate our ASCII, we could use two 74165s connected end to end, with the SI or serial input of the right one connected to the Q output of the left. But for demonstration purposes, the simple register you have already built out of some flip-flops is good enough.

The last thing we need is a control circuit to operate the shift register properly. We need a circuit to provide the proper handshaking with a computer port, control the loading and shifting of the register and also provide the right number of shift pulses at the right speed. This is shown in Fig. 10.

To analyze Fig. 10, start at the top. Here we have the shift register—just blocked in since the exact circuit will depend on the particular ICs you use. Down near the bottom we have an input labeled 2X CLOCK. This is a clock pulse signal from some clock oscillator, which has a frequency twice what we need, indicated by the 2X. This frequency is fed into the clock flip-flop, one half of a 7473, which divides it by two to get the correct frequency.

For instance, to transmit at 300 baud, we would start with a clock that operates at 600 pulses per second. This clock is then divided by 2 into 300 pulses per second, and this is applied to both the shift register clock inputs as well as to a 7490 counter.

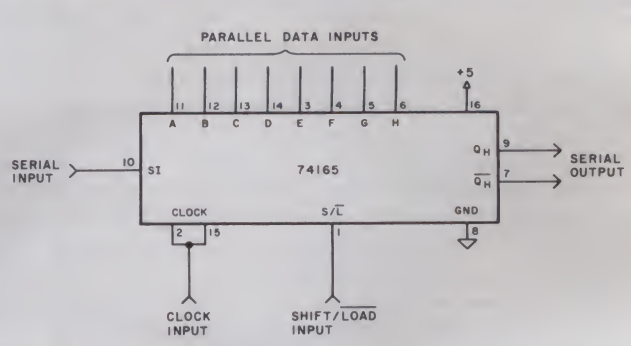


Fig. 9. Pin-out of the 74165 parallel-in/serial-out shift register.

But there is a catch—notice the wire running down to the clear input of the 7473 from the other flip-flop, called the ready flip-flop. If this flip-flop is set, meaning that the circuit is ready for the next character, then the signal going down to the clock flip-flop is a low level, and the clock flip-flop has to stay reset. So then nothing happens.

During the ready state, then, there is no shifting. Actually, there is no shifting for a second reason, too—the same low signal is being applied to the shift/load inputs of the register and holds it in the load state. But in your experiment, this need not concern you since you do not have a shift/load input on your shift register.

While all this is happening, the ready flip-flop's Q output is high and is sending a READY signal back to the computer. This high signal is also going to the reset input of a 7490 decade counter, keeping it reset to 0000. (More on this later.)

Now let's say that at some point the computer wants to send out an asynchronous ASCII character. First, it sends it out in parallel to the shift register, which simply loads it into the flip-flops. (In your experiment, you will fake this part by setting or resetting the flip-flops by hand.) Then it sends a negative-going START pulse to the preclear input of the ready flip-flop.

Now the circuit finally starts to work. The START pulse clears the ready flip-flop. This does four things: (1) the READY signal to the computer goes low, telling it that the circuit is no longer ready; (2) the reset signal to the 7490 counter also goes low, releasing it from its reset state; (3) the shift/load signal goes high, letting the shift register shift when it gets clock pulses; (4) the same signal goes down to the clock flip-flop, and its clear input goes high . . . this stops holding this flip-flop reset.

Everything now waits for the next clock input to come in. As soon as it does, the clock flip-flop will start to work, and clock pulses will start reaching the shift register.

But these same clock pulses are going to the 7490 counter. This is a decade counter, meaning that it counts by 10. Actually, it counts up to 9 or 1001, and then on the next count it resets itself back to 0000. After exactly ten shift pulses, its last flip-flop (which feeds the D output on the diagram) will go from 1 to 0.

But notice how this D signal goes back to the clock input on the ready flip-flop; moreover, its J input is connected to +5 volts, and its K input is grounded. So at the tenth clock pulse, just as the 7490 counter changes from 1001 (nine) to 0000 (zero), the ready flip-flop again sets. This stops everything dead and sends the READY signal back to the computer.

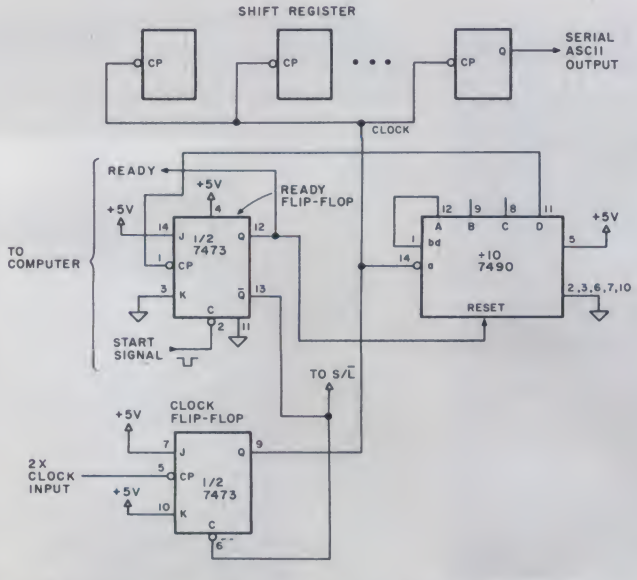


Fig. 10. Control circuitry for a parallel-to-serial asynchronous transmitter.

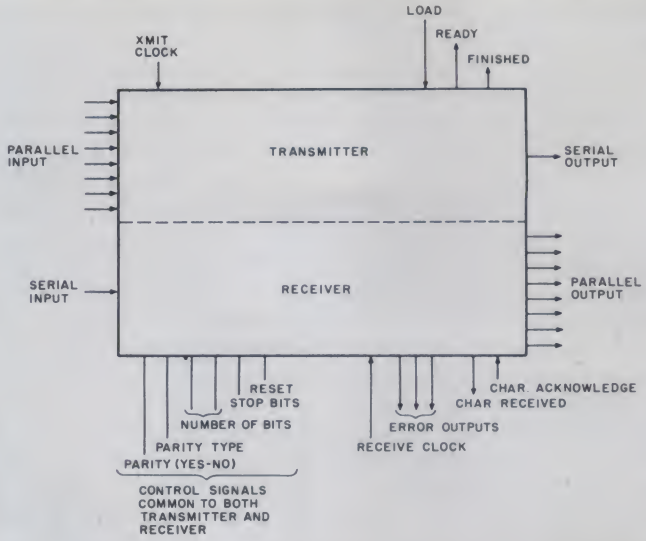


Fig. 11. Typical pins on a UART.

Here we have a circuit that shifts out exactly ten bits and then signals the computer that it's done and ready for the next character.

You may wonder why we used a 2X clock and a flip-flop to divide it back down again. We could have used a 1X clock—meaning one that ran at the right frequency—and started and stopped it by sending it through a gate that had the shift/load signal on the other input. This would have worked; but not always reliably.

It's a matter of timing. Suppose that the computer sent the START signal at the exact time that a clock signal came from the clock. The shift/load might arrive just in time to let just part of the clock signal through the gate. The resulting strange waveshape of the clock might be good enough to operate some flip-flops but not others in the register or 7490 counter. Then things might not work quite as expected. The best way to avoid problems such as this is with a circuit like this one.

Wire up the circuit of Fig. 10 and add it to the shift register. For clock pulses, use the pulser on your breadboard console and pulse the clock flip-flop slowly enough so you can observe the output of the rightmost flip-flop on an LED or a meter. Also connect an LED to the output of the clock flip-flop and the ready flip-flop, so you can see how they operate and so you can also count the right number of clock pulses.

If you do not have a 7490 decade counter, you can use a 7492 divide by 12, a 7493 divide by 16 or even make up your own counter from some flip-flops. But if you do use separate flip-flops, use the shift/load signal to reset the counter if the flip-flops require a low level rather than a high to reset to zero.

When you do this experiment, you will not be able to generate an entire eight-bit ASCII character since you probably have fewer than ten flip-flops, but at least you will have a chance to see how the control circuit works. *Moreover, this* circuit is a good example of parallel handshaking with a computer, since it has both a START signal as well as a READY status signal.

The UART

The circuit in the previous experiment is fairly complicated, but it's still much simpler than the circuit you would need to receive asynchronous data rather than transmit it. Receiving involves quite a bit more,

because it requires that you adapt to the timing of the sender, rather than just send out the data at your own speed. Up until a few years ago, designers had to make their own asynchronous ASCII transmitters as well as receivers. But now all that has changed with the UART, or universal asynchronous receiver transmitter.

The UART (about $5-10) is a 40-pin IC that can both receive and transmit asynchronous data. Fig. 11 shows the connections to a typical UART. The unit has two more-or-less independent parts—the transmitter shown at the top and the receiver shown at the bottom.

The transmitter accepts a parallel input of up to eight bits and provides a serial output. It requires an external 16X clock, which must run at 16 times the baud rate. For a 110 baud signal, for instance, the clock must be at 1760 pulses per second. The transmitter also has a LOAD input and READY and FINISHED outputs, which would go to the computer's parallel port.

The receiver is the reverse of the transmitter—it inputs a serial asynchronous signal and outputs a parallel character. It has a 16X clock input, as well as two handshaking signals—a CHARACTER RECEIVED output and CHARACTER ACKNOWLEDGED input. It also has three error outputs, which provide a signal to the computer if something goes wrong.

The UART is a versatile circuit that can be used in various ways by being set to various operating modes with a number of control signals common to both the transmitter and the receiver. These can select the type of parity, the number of bits sent and the number of stop bits.

We won't go into the UART in great detail since it has been covered in a variety of other articles. If you are interested in serial and parallel computer communications and more information on the UART, a good, inexpensive book is the *TV Typewriter Cookbook* by Don Lancaster, available from the KB Book Nook and at Radio Shack stores.

Preview

Next time we will continue our discussion of computer input and output, but from the computer side rather than the I/O device side. We will see how handshaking and data transfer are handled by various processors. Most interesting, we will look at interrupts. See you then!■

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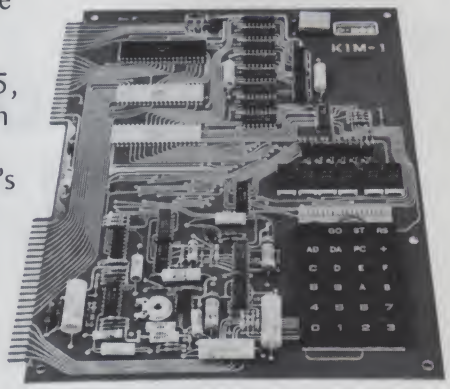
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A financial genius, an industrial guru or another person of exceptional insight is not required to forecast the most promising market for the majority of current computer stores.

The personal computer market offers little promise to the computer store. If the widespread market for appliance computers exists, and there are serious doubts that it does, this market will likely be dominated by mass retailers. Large retail operations (Radio Shack is a perfect example) can mass-produce inexpensive personal computers in quantities far greater than most computer stores can even dream of.

The hobby computer market offers little additional promise. Outside of the few areas where there are high concentrations of technically oriented individuals, there are simply too few people to support more than one hobby computer store.

Besides, the technically oriented hobbyist often tends to be the type of person who does not require, and is not willing to pay for, the support a computer store offers. The technically oriented hobbyist would rather save a few bucks by ordering a bare board from a mail-order house and appropriate the chips from work. The bottom line is that most hobbyists simply do not spend the type of dollars necessary to keep a store in business.

By far the most promising market for the majority of the current crop of computer stores is the vast number of businesses and schools that are literally crying for professional-quality computer hardware, complete service support and well-designed application software—all at a reasonable price. A few manufacturers are currently producing products that fill the need for reliable, professional-quality hardware. Several computer stores are now, or will shortly be, ready to provide the support a business demands. It is now past the time for the industry to produce well-designed application software to be made available for either off-the-shelf delivery by local computer stores, or as a basis for field modifications by the local computer store.

The Data Group, Inc., has been predicting these developments in the microcomputer market since late 1976. It was our own need for good business software, and an acute awareness of the needs of the industry, that led us to begin devoting the majority of our energies to producing the kind of business software that will help open this vast market to our fellow computer stores.

Inventory Control—Every Business Should Have It

For many businesses, particularly the retail and wholesale businesses for which POSIS was designed, the largest single asset item, by far, on the balance sheet is the investment in inventory. You cannot overemphasize the need for a business to keep tight controls on its largest investment. One of the keys to the success of many small businesses is to maintain inventory at such a level that a minimum amount of costly capital is invested, yet still keep a sufficient stock of the right kinds of products on hand and available for delivery.

The vast majority of small and medium-sized businesses still use the slow, costly, ineffective manual systems, if they maintain any inventory records at all. These systems generally require one or more clerks to laboriously take information from documents recording the sale and delivery of inventory and write the information onto some sort of file card. In the rapidly moving business world of today this method is clearly unacceptable.

The problems with manual inventory systems are many. One of the most obvious problems is the lack of timely accumulation of information. In a business with even a moderate number of daily transactions, it

1. 8080 or Z-80 based, S-100 bus microcomputer.
2. 48,000 bytes RAM addressed 0000 H-BFFF H.
3. One Micropolis dual-drive floppy-disk system (630,000 bytes of disk storage). A copy of Micropolis Disk BASIC Version 3.0 is also necessary.
4. An interface board with at least one RS-232 C port. Additional parallel or serial ports may be necessary depending on the type of printer (if any).
5. One serial video terminal (a Soroc IQ 120 is recommended).

Fig. 1. Hardware requirements to use POSIS (standard system configuration).

is certainly not unusual to find that information on the inventory file cards is as much as several days to several weeks out of date. Perhaps the only thing older than yesterday's news is yesterday's, or last week's, stock list. Up-to-date information is absolutely vital to a well-run inventory-control system.

Manual inventory systems are subject to all manner of human errors, ranging from errors in addition or subtraction to information recorded on the wrong file card. Even the best posting clerks make mistakes, which, at best, require a great deal of time to find and correct or, at worst, can cause lost sales due to the lack of an item in stock. Accurate information is absolutely vital to a well-run inventory-control system.

I could easily write pages on the inadequacies of manual inventory information systems. Most businessmen, however, are quite well aware of the inefficaciousness of manual systems and probably do not need or want to be reminded of such problems.

Microcomputers to the Rescue

POSIS, when used with a microcomputer system, allows small-to-medium-sized retail or wholesale businesses to use computers to put an end to the inefficiencies of manual inventory systems. The benefits of computerized inventory control using microcomputers are many; the risks and costs are few.

For many businesses the primary reason to switch to a computer is to eliminate the need for additional personnel. When you figure the cost of wages, employment taxes and miscellaneous costs, a clerk of minimum competence will cost at least $10,000 per year, probably more. A microcomputer using properly designed software will, in many cases, allow a company to process far more transactions without the need for additional personnel.

That a computer increases the efficiency of a business has been proven so many times that I will not waste time with examples. Since a microcomputer with POSIS will probably cost less than $10,000 and will certainly replace at least one additional person, the payback period will be one year or less. When you add in tax advantages, such as the 10 percent investment tax credit, the total cost of the system is reduced even further.

POSIS, A Summary of its Features

There are many reasons why we at The Data Group think POSIS is a major step forward in microcomputer-based business software. One of the most important is the basic philosophy behind POSIS. When we design a computer-based information system we do just that —design an information system. It just so happens that the tool we use to store and manipulate the information is a computer. The distinction we are attempting to draw here is between writing a computer program to produce business information and designing an information system around a computer.

It has been our experience that computer programs to produce business information tend to be written by programmers *for* programmers and, as such, fail to include many vital features. Our philosophy of designing an information system using a computer means that we approach the problem by realizing that clerks, managers and accountants, not programmers, are going to be the primary users of the system.

A computer system that is meant to be used in an environment where the majority of users are unfamiliar with computers *must* be totally interactive with the user. In other words, the computer must converse with the user in plain English, not in computer jargon. We consider this a prime factor in making POSIS a workable system. Aside from a couple of BASIC commands used to load POSIS into the computer from the floppy disk, POSIS leads the user every step of the way through the use of standard English.

In many computer programs currently available for microcomputers, we have found that there are many times when the user could easily be dropped out of the middle of the program because of a simple error in entering data. Many users, when confronted with an error message, a program line number, and a program statement, would have absolutely no idea what to do next. Futhermore, they would have no idea, and no way of finding out, what information had been altered before the program crashed and what information still had to be entered. This is totally unacceptable in a business environment.

POSIS contains the most extensive error-handling capabilities we have seen to date in microcomputer software. With POSIS, there are only a couple of obscure instances when an operator error could crash the program, and these errors are specifically stated in the instruction manual. In some cases POSIS will even question and refuse to accept information, such as unbalanced journal entries, that is obviously in error.

Security of both the computer itself and the data within the system is of prime concern in POSIS. Before a person is allowed to see the main menu (the list of possible functions within the system), a valid employee ID code must first be entered and verified by POSIS. When the employee has chosen which operation he wishes to perform, he must then enter the proper password for that operation.

Various operations are available to different employees depending on their level of authority. To prevent an employee from just sitting at the terminal and trying various combinations, the system will allow only five attempts to enter either the employee ID or password before denying that person access to the system and recording the attempted breach of security.

The vast majority of user errors that could cause destruction of information stored on the disks have been anticipated and are handled by the system. Further integrity of the data has been achieved by a simple, yet complete, regime of maintaining backup copies of all data that might be subject to destruction.

In addition, we use the *transaction diskette* method of storing the information that is entered into the system. The data entered into the system is recorded on one particular diskette which, at the end of the day, is used to update information on a permanent *accounts*

1. A hard-copy device (printer).
2. Additional 12,000 bytes RAM.
3. Additional Micropolis dual-drive floppy-disk system (total of 1,260,000 bytes disk storage).
4. Additional video terminals and associated hardware. Note: Access to the computer by additional terminals will be serial, that is, only one terminal will be able to access the system at any one time. All other will wait.

Fig. 2. Optional hardware.

diskette. In the unlikely event of a power failure or other major interruption in the use of the system, the permanent information on the accounts diskette and other records generated either by the system or manually can be used to reconstruct the lost data.

In the writing of computerized information systems, one person who almost always seems to be overlooked is the accountant. POSIS was designed by an accountant with the needs of the auditor or accountant in mind. POSIS records a summary of each and every piece of information entered into the system and provides a clear, easy-to-follow audit trail in order that an independent auditor may verify the accuracy of the information stored in the computer.

Double-entry accounting, balancing the debits and credits, is universally accepted in the United States as the proper accounting method. This may seem to be a self-evident statement; however, it is one that must be considered in designing an accounting system. All accounting information contained in POSIS is in the form of offsetting debits and credits. This provides another self-check within the system against both human and hardware failures.

From the viewpoint of the accountant, an area of prime concern is that an inventory control system maintain an accurate, consistent and sound method of placing a value on the inventory. A great deal of thought has been put into the inventory valuation method POSIS uses. Since most businesses use a FIFO (first in-first out) method of inventory valuation, this is the valuation method we chose for POSIS.

It is also important to remember that in actual business situations a product may be in stock at more than one price. While the details of how POSIS handles multiple levels of inventory costs are very lengthy, it is important to know that POSIS recognizes the prime importance of inventory valuation.

One of the major complaints about the entire microcomputer industry is that there is a severe lack of proper documentation. POSIS comes with an extensive user's manual that not only explains in detail the operation of POSIS, but also devotes considerable material to the use of POSIS as part of an accounting and management information system.

Additional documentation available to distributors and dealers includes a completely documented programmer's manual with flowcharts, information about the structure of the data files and other information necessary to proper field maintenance and modification.

The accompanying figures provide an overview of POSIS. Fig. 1 lists the hardware configuration necessary to run POSIS; Fig. 2 lists optional hardware that POSIS can use; Fig. 3 lists the information stored on each item; Fig. 4 lists the accounting information stored in POSIS; and Fig. 5 lists the reports generated by POSIS.

POSIS is now available for delivery to individual users at a cost of $750. Dealer inquiries are welcome. The Data Group, Inc., 8077 Bramwood Ct., Indianapolis IN 46250. ■

NAME	STORAGE FORMAT	# DIGITS (CHARS)
Manufacturer Code	xxx	3
Item Code	xxxxx	5
Special Order Code	x	1
Product Description	xxxxxxxxxxxxxxx	15
Retail Price/unit	xxxxx.xx	8 (incl '.')
Min Stock Level	xxxxx	5
Max Stock Level	xxxxx	5
Current Cost/unit	xxxxx.xx	8
# in Stock (current cost)	xxxxx	5
Previous Cost/unit	xxxxx.xx	8
# in Stock (previous cost)	xxxxx	5
Last Order Date (purchase order date)	xxxxxx	6
# Ordered—Last Order Date	xxxxx	5
Tot # Ordered—Not Recv'd	xxxxx	5
Tot # Back Ordered	xxxxx	5

3000 unique products may be stored with the standard system configuration. The addition of the optional dual-drive floppy-disk system will increase the number of products by 9000.

Fig. 3. Information stored on each item in inventory (© 1978 by Bruce A. Barker).

Format	Account #	Account Name
x,xxx,xxx.xx	102	Cash
xxx,xxx,xxx.xx	120	Inventory
xxx,xxx.xx	129	Inventory receivable
x,xxx,xxx.xx	201	Purchases
xxx,xxx.xx	260	Deposits received, goods not delivered
xxx,xxx.xx	250	Sales tax payable
xx,xxx.xx	280	Charge-card fee payable
xxx,xxx,xxx.xx	8100	Sales
x,xxx,xxx.xx	8130	Service
xxx,xxx,xxx.xx	8200	Tax-exempt sales
x,xxx,xxx.xx	8230	Tax-exempt service
xxx,xxx,xxx.xx	7100	Cost of goods sold
xxx,xxx.xx	7370	Charge-card expense
xxx,xxx.xx	7110	Incoming shipping expense
xxx,xxx,xxx.xx	9010	Loss due to theft, damage, etc.

Fig. 4. Accounting information stored (© 1978 by Bruce A. Barker).

1. Items over or under maximum/minimum stock level (items needing to be reordered).
2. Stock reports.
   a. Price List.
   b. Full report of all information stored on each item.
3. Recall sales receipts by receipt number, or list all sales receipts.
4. List summary of all transactions entered on a diskette.
5. List attempted security breaches.
6. List items on back order.
7. The following sales analysis reports will be available in future updates: (those with * are now available)
   *a. Inventory mix report (percent of total inventory represented by each item).
   *b. Sales mix and turnover. Percent of total sales represented by the sales of each item. Number of units sold per month.
   c. Gross margin analysis. Percent of total gross profit represented by the individual gross margins of items sold.
   d. Other reports may be added as requested.

Fig. 5. Reports generated.

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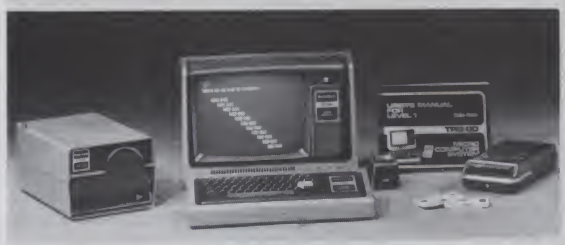
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It's fun to toot your own horn once in a while. This unsolicited (no kidding!) review describes and evaluates a pair of PET programs from our Instant Software line.

D. Borland
36 Ainsdale Rd.
Toronto, Ontario M1R 3Y8

Both programs are prerecorded on one cassette, nicely packaged in a hard paper box with imprinted names of the progams. A small booklet containing the program listing and instructions on how to run the programs is enclosed.

The first program, "Financier," is definitely the best and the most useful financial application I have seen so far on personal computers. It can perform ten different financial calculations, such as one-time investments, regular deposits, remaining balance on a loan, etc.

The program is truly self-explanatory, and I could operate it even without looking at the enclosed booklet. After I typed in "RUN," the program displayed the heading with the program name and description, and then it advanced to the next screen with a list of the available financial groups (investment, depreciation, loans). I first selected the "Cost of Borrowing" option in the loan group, and then I ran it several times, varying the interest rate and term of loan, trying to find *the* lowest cost. Also, the other options are quite useful, particularly the investment group with the breakdown of invested capital, accumulated interest and the total value.

Operating the program for the first time, I was confused about the correct input for the term of investment. As I entered the full year only, another prompt for the number of months was produced. This denotes that when the term is entered, both the years and months are to be entered and separated by a comma.

The entire program resides in about 7K, and after the allocation of the variables, I found there were only 20 bytes left in the memory. However, the program doesn't make use of overlays, as some of the bigger programs do, and thus the entire program resides permanently in the memory. Because of the size, it takes rather long to load the program into the memory (about two minutes). Once the program is in the memory, it will execute surprisingly fast. The screen layout is neat, and the formatting of the displayed results is nicely arranged. I especially liked the alignment of the monetary amounts in the breakdown and totals.

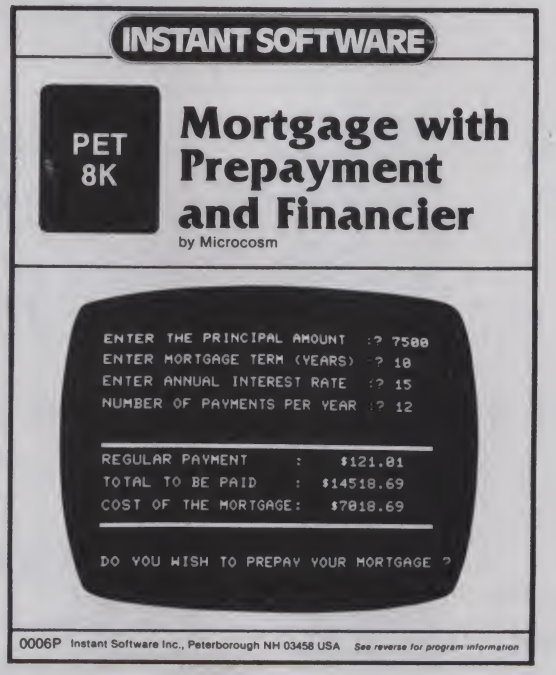
The second program will be of use primarily to people contemplating the purchase of a home or currently financing a mortgage. First it calculates and displays the regular payments on a loan or mortgage. In contrast to other mortgage programs, this program demonstrates the savings resulting from paying the anniversary prepayments on the mortgage.

I was surprised to learn that if I borrowed on a short-term loan for the prepayments, even at a higher interest rate than the original mortgage, I could experience a savings.

Well, if you are thinking about purchasing a house or condominium, then you would be well advised to invest first in this program and a PET, if you don't own one yet. Then you can run a couple of calculations, find the optimal mortgage and prepayment for you, and the achieved savings will surly justify the cost of your computer. You may even find enough money from the savings to upgrade your equipment. There are two more options in the program—one is the amortization schedule for a mortgage with or without the prepayment; the other is a detailed explanation of how the prepayment works. The progam is easy to operate and the screen layouts are well designed.

Two things in this progam deserve comment. (1) The mortgage calculation employs the simple monthly interest method, whereas most Canadian mortgage companies use semiannually compounding methods. (2) The progam does not allow for variable prepayments. Also, this program seems to use a lot of memory (there were only 101 free bytes left over).

In summary, if you own a PET computer this package is an excellent buy for $7.95. I suggest you take a look at it during your next visit to your local computer store.■



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Hey, Kids! It's "Mickey Modem"! (Not a Toy)

We've all been waiting for this—an excitingly simple way to interconnect computers via the telephone lines. Well, wait no longer! We feel certain that you'll love this.

Stephen Gibson
PO Box 38386
Los Angeles CA 90038

The most practical way for computer hobbyists to trade programs is by direct computer linkup. Paper tape, cassettes, disks and printed listings are only stepping-stones to getting the program out of someone else's machine and into yours. Sure you want a copy to save for later use, but you may have to wait until the next computer club meeting or a more convenient time to swap your software.



Use your computer as a stand-alone terminal by tying the cassette port to Ma Bell with simple software and this handy gadget.

The simple solution is to interconnect your computers over the normal telephone lines. Not only could you trade programs, but also you could have some real fun with your hobby by playing interactive games. After all, why should you always lose to your computer? At least you have a chance when you play another human!

Easier Said Than Done

Most computer-to-telephone interfaces used today are called *modems*. They convert your computer's TTL, current loop or RS-232 levels to tones that can be sent over the phone lines at a reduced error rate using a method of frequency shift keying. They generally use two separate frequency bands for transmission and reception. In the Bell 103 modem, for instance, 1070 Hz and 1270 Hz are used to send, while 2025 and 2225 are used to receive.

To communicate, one hobbyist uses a modem like the 103 above called an "originate" modem. The other hobbyist must use a different modem with opposite sets of send and receive frequencies called an "answer" modem.

That these terms, originate and answer, make no sense in a hobbyist computer-to-computer linkup is just the tip of the iceberg. So far, we might need one each! Nice redundancy, but lousy economics because modems in general aren't inexpensive. Unless you build a kit or buy one new, you are forced to comb the surplus market for one with low mileage and price.

The real problem surfaces when you discover that most surplus modems are originate only! Besides the originate unit, you're going to need an answer modem, or better yet, a combo unit . . . and they're hard to find. On the other hand, you could try to modify yours to make it a combo unit. But overall, there's no easy way to get a modem working without having to shell out some cash and/or grief. At this point you might wisely consider the project a total waste and continue trading programs on cassette and the like.

Enter the Mighty "Mickey"

Why not send the cassette interface audio directly over the phone lines? And why can't you connect your computer's cassette port to the phone and talk direct or play games on each other's computers? It's possible. In fact, it works for most cassette I/O formats so long as you stay with the local phone lines. Long-distance lines have narrower bandwidth and exhibit other kinds of distortion that cause some cassette I/O formats to not work as well as others.

You can make a super simple interconnection with a gadget I

call "Mickey Modem" . . . because "Mickey" Isn't quite a modem. It's really two IC amplifiers wired to a hybrid network connected to your phone line.

A note of caution is in order here. Despite recent court rulings, you should still determine if your local phone company requires a coupler to the line. Mickey is legal for direct connection only in some parts of the country.

Disgustingly Simple Circuit!

Your computer cassette port output feeds line driver Amp A1 (see Fig. 1). The level is adjusted by R1 for 0 dbm on the meter. A1 drives the phone line through a network of resistors, R2, R3, R4 and T1. It is here that we are able to feed the proper level to the line from A1 but not overdrive the input amplifier A2 to hassle our eardrums . . . and the computers!

The way it all works is rather simple. Amplifier A1 feeds the junction of R2 and R3, and the signal is coupled to the line via T1. If variable resistor R4 is adjusted to equal the line resistance presented T1, the voltages from A1 that appear at the opposite ends of R2 and R3 will be equal. Therefore, the output of amplifier A2, wired in a differential mode, will be zero.

So much for theory. Actually, the best suppression you can get is wholly dependent on line reactance and may vary from 30 to 40 db. At worst, this is more than adequate for a condition here that calls for only 10 to 20 db rejection. In practice, R4 is adjusted for an equal send and receive level from the speaker and simply forgotten. More on this later.

The signal coming in from the line is amplified by A2 and feeds the computer's cassette port input. It also feeds a speaker through a 47 Ohm resistor for a convenient volume. The .005 capacitor across R7 suppresses noise from the line only at high-gain settings due to the parallel RC combination.

Easy-Construction Tips

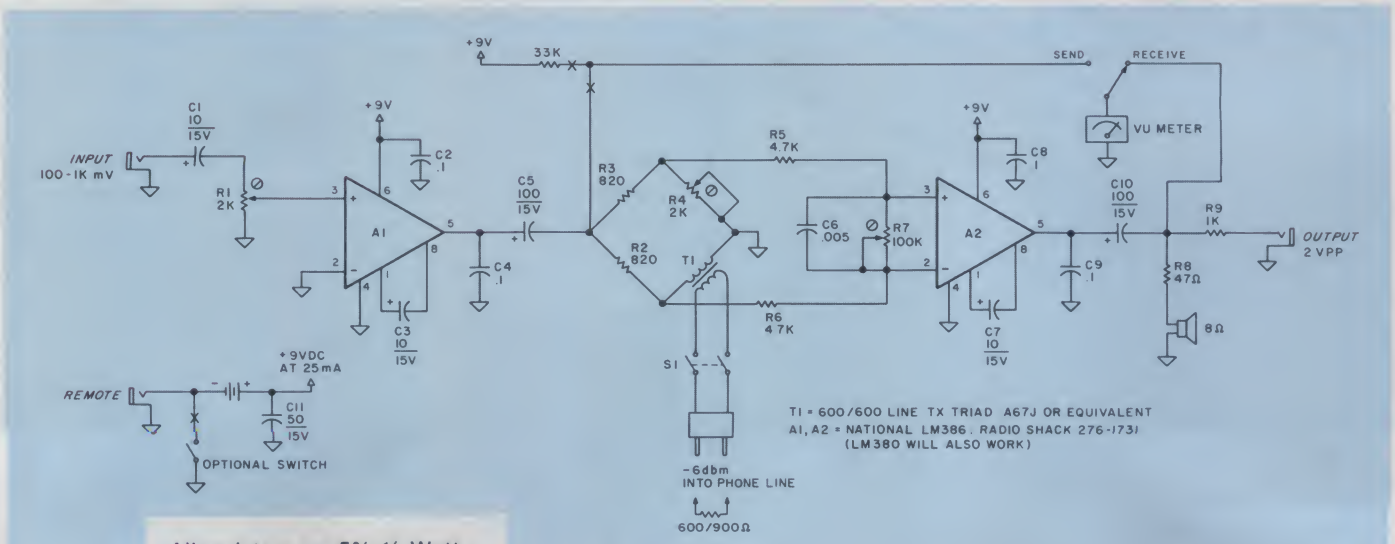
"Mickey" can fit into any box you may already have. After all, 2 ICs, a transformer and batteries don't take up much space. on the other hand, you might decide to use a larger, more attractive case as seen in the photos. This would provide you with space for sound effects or music goodies when you add them . . . especially since you already have an amplifier wired up, ready to go!

The meter and controls fit nicely on the sloping panel of an LMB 1042 box. The I/O control jacks are located on the side. I put mine in the same relative position as those on a Radio Shack CTR-41 recorder. A TRS-80 user might find this location very convenient. Simply exchanging the plugs from the recorder to Mickey Modem is all that is necessary to interface the TRS-80 to Ma Bell!

I assembled the circuit on a Radio Shack 276-151 Experimenters PC board. A board half this size would have worked, but why bother if you plan to shove it into a big box? The transformer is mounted on a scrap piece of aluminum and bolted to the case with 6-32 hardware. Even though the average local loop Impedance between your phone and the central office is around 900 Ohms, a 600/600 Ohm line transformer will work just fine for T1. I used a Triad A67J, but a cheap import 600 Ohm or even 1000 Ohm unit will work because the signal Is under a milliwatt, and R4, when adjusted, equalizes the slight mismatch.

The application notes for the LM-386 IC amplifier call for a 10 Ohm resistor and a series .1 uF RC combination to suppress an annoying oscillation that occurs at higher current levels. I breadboarded the circuit and discovered that the unit works very well without the 10 Ohm resistor In this particular application. That's two less parts to dig up. Controls R1 and R4 can be PC card pots. You will set them only once.

The unit is activated by the computer. Why not? The TRS-80 and the Tarbell inter-



All resistors are 5% ¼ Watt.
All 'lytics rated over 9 V (15 V).
An import 600/600 tx will work.

The gain of either amp can be reduced from 46 db to 26 db by removing C3 or C7. R1 and R4 are audio taper and can be mounted on circuit board. They are set only once. You may not need the VU switch. Just hard-wire to the "receive" line. Radio Shack 276-151 PC board is a simple way to go.

Setup: Feed 400 Hz @ 100 mV rms into input and set R1 level for -6 to -10 dbm into phone line. Unit must be connected to 600-900 Ohm load for test. (The line is a good 800-900 Ohm load!) Adjust R4 for a minimum level on "receive" VU position. A -30 dbm 600-900 Ohm signal into the phone jack will put about 2 V P.P. at output jack. C6 cuts nolse on the line only at high volume settings. C4 and C9 cut low end "fuzzies." TRS-80 fans should connect "ear" line to Output, "aux" line to Input and remote to remote!

Fig. 1. Only two IC amplifiers and a hybrid network are needed to interface cassette port audio to the phone lines. The wires marked with an "X" are possible modifications to read battery voltage after initial calibration. See text for details.

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faces have this capability. Before a cassette read or write, a relay, operating under software is closed and turns on the unit. If the battery life is unimportant, you can simply substitute an SPST switch for the remote jack function. I wired two batteries in parallel . . . hardly worth the effort because the unit draws a paltry 25 mA.

Be sure to use shielded wire between the circuit card and the controls. The high gain of the IC Amps can cause unwanted oscillation due to feedback. If you use a common ground bus and ground all shields at one point, you'll do fine.

Final Operational Checkout or Making "Mickey" Talk!

Install a spare telephone jack next to your phone and a mating plug on the end of "Mickey's" I/O line. "Mickey" should be wired to the red and green wires of the telephone jack. If the Remote jack circuit is closed, you should hear a nice loud dial tone from the speaker when S1 is switched to the line. You can test the unit with tones from the cassette port, but I suggest you conduct your tests back at the bench before you connect "Mickey" to the telephone network.

Bench checkout should give the following results. A 600 Ohm, −30 dbm RMS signal at 400 Hz fed to "Mickey's" telephone line input should produce better than 0 db on the meter with R7 wide open. The signal feeding the computer will be around 600 to 800 mV RMS and present a source resistance of about 1000 Ohms.

Looking the other way . . . a 100 mV signal from the computer should be adjusted by R1 to read 0 db on the VU meter, which will produce −6 to −10 dbm into a 600 to 900 Ohm load connected to "Mickey's" phone line jack. You can remove C3 to drop the gain of A1, 20 db if your computer output level is greater than 100 mV.

R4 is adjusted by feeding a signal from your computer into the line after you've reached another user. You simply set the VU switch to "receive" and adjust R4 for a minimum reading on the meter. You are looking at feedthrough from A1. So if the meter is reading off scale, simply reduce the "send" level long enough to find a convenient R4 null point. This is not a critical control from a circuit operation standpoint. Its primary purpose is to maintain reasonably even speaker volume levels between send and receive.

You may not ever need to reset this control, even though you may be communicating with several users at various distances from you because you



A hold button cuts noise on the line during data transfers. The unit in the photo is marketed under the name "Phone Censor" and is easy to install between the microphone and the handle.



Mounting I/O and control jacks in the same position as the cassette recorder makes changeover to Mickey Modem a snap. Here, the jacks line up with a CTR-41 recorder for a TRS-80 computer.

will always be tied to the same amplifier at the central office. And unless the phone company installs an extra couple of miles of cable between you and that first amplifier, you just set R4 once and forget it!

Some Nifty Mods

Inasmuch as the send level is preset, you might choose to eliminate the send/receive meter switch and permanently wire the unit in the receive position once the level is set. Just be sure all your level setting measurements are made with a 600 to 900 Ohm load across the phone jack or with the unit connected to the line. Proper levels are essential for legal operation.

Another way to utilize the VU switch might be to disconnect the line from the "send" position and connect a 33k resistor from the battery to the switch instead. You can then check on battery voltage without opening the box. When the battery drops below about 7 volts, the meter will no longer read above 100 percent and tell you it's time for a change. Adjust the resistor size to suit your own tastes; the VU indication is only relative. You can operate the unit with or without your phone off-hook.

A useful device that's marketed under several names as seen in the photo can function as a quickie "hold" button. It slips between the microphone cartridge and the handle of the phone. A button on the side allows you to shut off the mike during a data transfer, yet allows you to listen or carry on a conversation. This is a very nice feature when you are both debugging a piece of software. Two users can discuss various mods, then squirt them back and forth until either person finds a solution.

I use a Heathkit speakerphone and leave it off-hook nearly all the time. Keep in mind that a phone that's off-hook will load the line and lower the level. It may even throw the network balance (R4) off enough to be an annoyance. While "Mickey" has reserve gain, you still might find you can ruin a data transfer if you lift off-hook in the middle of something.

Real Software Fun!

Once you've passed the checkout phase, you can trade programs with ease. You simply type "CLOAD," for instance, while the other computer is in the "CSAVE" mode. Other cassette I/O conventions exist, but I'm sure you get the idea.

Now for the interactive connection. This next step is where the real fun of this hobby begins. To illustrate the point, I've included an interactive program. The only translation problems you might have are those relating to your cassette I/O commands. For example, Radio Shack BASIC software incorporates a "PRINT #" and an "INPUT #" command to read and write data variables to cas-

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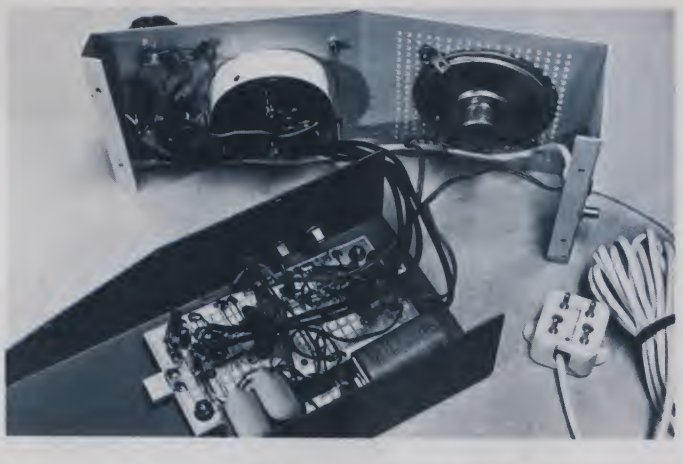
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The circuit is assembled on an Experimenters PC board and bolted to the case bottom with the transformer and batteries. Shielded wires are used between the circuit board and the controls to eliminate feedback. Control R4 can be mounted on the board or the rear of the case as shown. A standard four-prong telephone plug connects the unit to the line.

sette.

Other cassette I/O commands such as "OUT" can be easily adapted to this TRS-80 program. You can do it with Mits ACRs or Tarbells to name just two. Simply substitute the appropriate cassette I/O command.

The only interactive software difficulty that I've encountered involves keeping track of each user's variables and system timing. A generous use of FOR/NEXT loops keeps each user in step and obviates the possibility that one machine may enter a data transmission mode before the other is ready to receive. This all happens in a fraction of a second, and the users are generally not aware of it . . . but neither can they screw it up!

Interactive 23 Bytes . . . Just to Get Your Feet Wet

The game of 23 Bytes (Yup . . . bytes!) is a good example to illustrate foolproof interactive operation. The rules are simple enough. "You see, there is this stack of 23 bytes." The stack, as many soon learn, is from the top . . . down.

Anyway, someone goes first and can remove one, two or three bytes from the stack. The other player takes his turn and removes one, two or three bytes from the stack. Each player takes a turn, and the stack shrinks. The player that must take the last byte loses. Similar versions of this BASIC program use 23 matches or 23 cards. Usually you play the computer and lose . . . until now!

Program Description

The program goes through the initialization machinations up through line 75. The CLS command clears the screen in Radio Shack BASIC. The line 4000 subroutine called in line 15 gets your name and your opponent's (A$ and B$). Variable J is simply a game counter.

Someone must go first. Since you both are operating on independent computers, you must make this decision ahead of time. Naturally you could have one computer decide, then tell the other, but let's stay with the basics, then branch out to other possibilities.

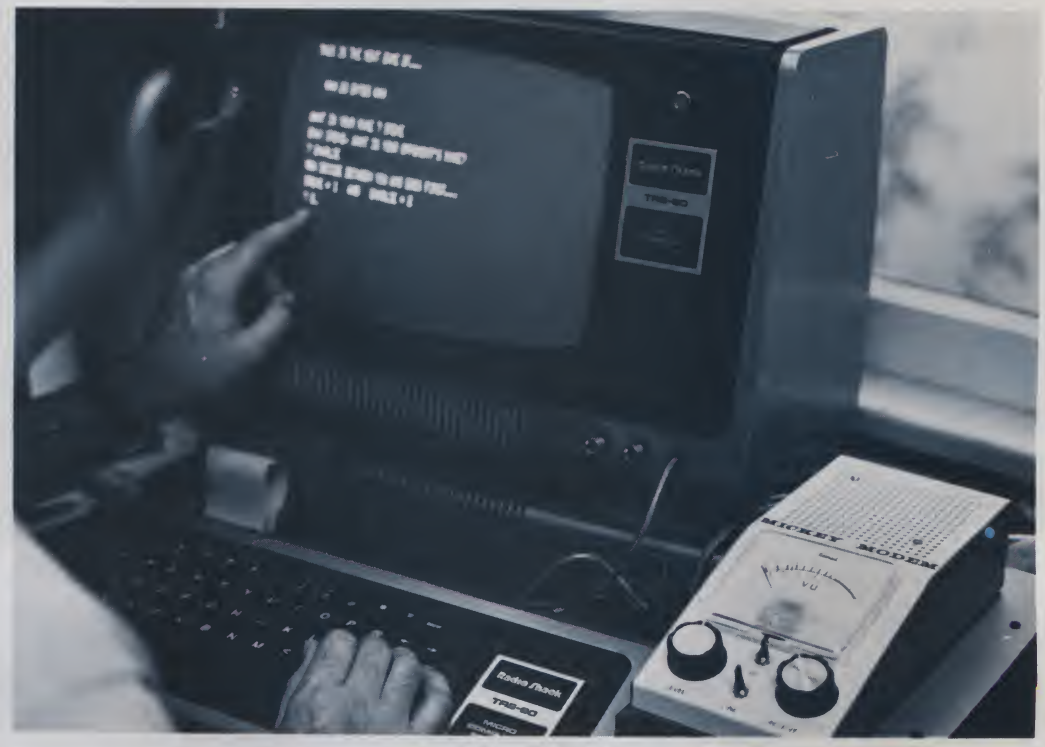
Once you decide who goes first and have entered it in the program Z, the computer then enters one of two routines beginning at line 100. If you were to go first, Z would be 1 on your machine, but it would be 2 on your opponent's. Based on the value of Z, your computer would enter the "Your Turn" subroutine at line 1000, while your opponent's machine enters the "Opponent's Turn" routine at line 2000 because the value he input to Z was 2.

Each computer trades off the value of Z (1 or 2) between each of you as you each take turns. Stated another way, your machine is in one routine while your opponent's is in another . . . then you each switch routines.

The other subroutine beyond this point is a timing loop called "wait loop" to assure both routines run in step. You can shorten this loop when you get the hang of interactive operation.

Digging deeper into the "Your Turn" routine, you're asked how many bytes you want in line 1040. The value you input is sent to your opponent's computer via the cassette port in line 1050. The line 3000 "Flag on Play" subroutine called in line 1060 then tests for valid play. The other variables in the "Your Turn" subroutine (W & L) are simply wrong answer counters for each turn. We exit the routine in line 1090. But not before we tell the computer that it is now your opponent's turn (Z = 2).

Going back to line 100 and the "Take Turns" routine, the computer now knows it is your opponent's turn (Z = 2) and so it branches to the "Opponent's Turn" routine at line 2000. These routines are essentially the



Playing interactive games over the phone lines is just one application for Mickey Modem. Businesses can exchange data between satellite offices. And the deaf network users can get rid of their old Teletypes.

same, except for the getting of data from your opponent's computer at line 2040. Notice that Z is reset to 1 (your turn) before we exit. So your computer, for want of better words, zigzags back and forth from these routines, depending on the value of Z.

The "Referee" subroutine at 3000 tests for a valid move, then performs the subtraction from the stack of bytes. If an invalid move was attempted, a branch is made to the line 3100 routine where both players are notified. The wrong answer counters are incremented, and the player is given a second chance. If he still "muffs it," the game is called. The routines at line 3200 and 3300 are the "Win/Lose" and "Game over" exiting routines.

If you've managed to stay with the program description to this point, you may notice that the routines are structured so they can be applied to nearly any interactive program. Of course, the rules and game-related calculations would be different, but the basic subroutine structure and counters can stay the same. Once the details are worked out, it is easy to apply your own pet games to this program structure.

Getting Started Is the Slowest Part!

Mickey Modem is so simple to build that just getting the parts together may be the hardest part. Nothing in the circuit is critical other than the need for adequate shielding. For many, the data exchange speed may be slow. But as the old computer bromide goes, "If it's faster than you can read it . . . it's fast enough!" If you find you really need more speed, then go for the throat and install a wide-band laser link.

On the other hand, you can have a ball with this arrangement, especially when you pull a super sneaky feat on your opponent by modifying the software routines in your machine so your opponent is really playing your computer alone . . . and losing! Devilish, isn't it?■

```
1 REM
2 REM INTERACTIVE 23 BYTES
3 REM BY SC GIBSON 1/9/77
4 REM
5 CLS:PRINT"THIS IS THE NEAT GAME OF...":PRINT
10 PRINT"   *** 23 BYTES ***":PRINT
15 GOSUB4000:REM GET NAMES
20 J=0:REM SET GAME CNTR
25 PRINT"NOW DECIDE BETWEEN YOU WHO GOES FIRST..."
30 PRINTA$;" = 1   AND   ";B$;" = 2"
35 INPUT Z :IFZ>2THEN30:IFZ<1THEN30:IFZ<>INT(Z)THEN30
40 CLS:PRINT"HERE ARE THE RULES..."
45 PRINT"WE START WITH 23 BYTES. EACH PLAYER IN TURN CAN TAKE"
50 PRINT"1,2 OR 3 BYTES FROM THE PILE. THE PLAYER THAT TAKES"
55 PRINT"THE LAST BYTE...LOSES!":PRINT
60 PRINT"I'LL BE THE REFEREE AND KEEP SCORE. NO CHEATING!!!!"
65 FORN=1TO1000:NEXTN:PRINT"OH YES....FOR THOSE OF YOU THAT WONDER,"
70 PRINT"A 'BYTE' IS WHAT RADIO SHACK GETS FROM IBM'S MARKET!!!"
75 FORT=1TO5:GOSUB5000:NEXTT
77 REM
80 REM BEGIN GAME HERE
85 GOSUB5000:GOSUB5000:CLS
90 PRINT"READY...":X=23:J=J+1:PRINT"THIS IS GAME #"; J
95 REM
100 REM TAKE TURNS FROM HERE
105 GOSUB5000:CLS
110 IFZ=1 THEN1000
120 IFZ=2 THEN2000
130 REM VERY HARD TO GET PAST HERE
1000 REM
1010 REM YOUR TURN
1020 W=0:L=0:REM WRONG ANSWER CNTRS
1030 PRINT"THERE ARE NOW ";X;" BYTES."
1040 INPUT"HOW MANY DO YOU TAKE ";Y:PRINT"THANK YOU.":PRINT"PLEASE STAND BY..."
1045 L=L+1
1050 PRINT#-1,Y:REM PRINT TO OTHER PLAYER
1060 GOSUB3000:REM TST 4 VALID PLAY
1065 IFL=2THEN1080
1070 IFW=1THEN1030:REM 2ND CHANCE
1080 Z=2
1090 GOTO100
2000 REM OTHERS TURN
2010 W=0:L=0:REM WRONG ANSWER CNTRS
2020 PRINT"THERE ARE NOW ";X;" BYTES."
2030 PRINT"AND NOW ";B$;" TAKES A TURN.  PLEASE STAND BY..."
2040 INPUT#-1,Y:PRINTB$;" JUST TOOK ";Y;" BYTES."
2045 L=L+1
2050 GOSUB3000:REM TST 4 VALID PLAY
2055 IFL=2THEN2070
2060 IFW=1THEN2020:REM 2ND CHANCE
2070 Z=1
2080 GOTO100
2090 REM
3000 REM 'FLAG ON THE PLAY TEST'
3010 REM
3020 IFY>XTHEN3100
3030 IFY<>INT(Y)THEN3100
3040 IFY<1THEN3100
3050 IFY>3THEN3100
3060 X=X-Y:REM YANK OUT BYTES
3070 IFX=0THEN3200:REM GAME OVER
3080 RETURN
3100 REM REFEREE SHOWS MUSCLES...
3110 W=W+1:CLS:PRINT"OK....BEEP...BEEP.....STOP THE MUSIC!!!"
3115 PRINT:REM SKIP SPACE WHILE COMPUTER COOLS OFF
3120 IFZ=1THENPRINTA$;
3125 IFZ=2THENPRINTB$;
3130 PRINT" JUST TRIED TO PULL A FAST ONE!"
3135 IFW>1THEN3300:REM REAL TROUBLE
3140 PRINT"I'M JUST AS SMART AS AN IBM 370 AND"
3150 PRINT"I KNOW MY BITS FROM MY BYTES...SO LET'S STICK TO THE RULES."
3160 PRINT"I'LL GIVE YOU ANOTHER CHANCE.":RETURN
3200 REM WIN/LOSE
3210 PRINT"TOO BAD...";
3215 IFZ=1THENPRINTA$;
3220 IFZ=2THENPRINTB$;
3230 PRINT" LOST THIS ONE.":PRINT"BETTER LUCK NEXT TIME."
3240 PRINT"OKAY...LET'S PLAY AGAIN.":GOTO80
3300 PRINT"THIS GAME IS OVER. ";
3305 IFZ=1THENPRINTA$;
3310 IFZ=2THENPRINTB$;
3315 PRINT" WONT PLAY FAIR.":GOSUB5000
3320 FORN=1TO10:NEXTN:PRINT".....SPOIL SPORT!"
3330 GOSUB5000:GOSUB5000:GOTO80
4000 REM
4010 REM GET PLAYER NAMES
4020 INPUT"WHAT IS YOUR NAME ";A$
4030 PRINT"OKAY ";A$;", WHAT IS YOUR OPPONENT'S NAME?"
4050 INPUT B$
4060 RETURN
5000 REM
5010 REM THE GEE WHIZ 'LET'S WAIT' LOOP
5020 FORN=1TO1000:NEXTN:RETURN
```

Program listing.

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- Unlimited length of strings
- Unlimited length of variable names
- Procedures with independent variables
- Number system 10 digits BCD integer or floating point

Included are commands unique to TARBELL CASSETTE BASIC which provide capabilities to:

• Initialize I/O channel • Assign a physical device to a logical device • Drop an I/O channel previously assigned • Save the BASIC interpreter and monitor or I/O routines on cassette • Cause programs to be appended onto programs already in memory • Call a procedure and pass variables on the list • Cause interpreter to enter edit mode using 15 single character edit commands.

Tarbell BASIC occupies 18K of RAM. Source is available on cassette, CP/M** Disk, and printout---all at reasonable prices. Price for TARBELL CASSETTE BASIC and complete documentation: $36.00.

CP/M Disk Operating System

The I/O section of this software has been modified to operate with the TARBELL Floppy Disk Interface in 24K bytes of memory. Five commands permit listing of directory, typing contents of an ASCII file, renaming a file, erasing a file from disk, and saving memory on disk. Fourteen programs are included which are invoked like commands. Six source files are included for transferring between TARBELL Cassette and disk, cold-start loading, Basic I/O system with drivers, and reformatting crashed diskettes. Documentation includes a listing of BIOS and instructions to patch CBIOS for your system. Price is $100 on CP/M diskette with documentation. (CP/M is a product of Digital Research).

CP/M 1.4 Update Package

A TARBELL Update Package for those now using CP/M 1.3 is now available on diskette. The Update Package adds new commands and the ability to access four disk drives, as well as 2 new CP/M manuals, TARBELL CP/M User's Guide and a new BIOS listing. Price: $50.00.

SPOOLER

This 8080 program will save many hours of computing time. It intercepts *all* output to the list device, spools the output to a high-speed disk file, and directs the spooled data to a low-speed printer during unused cycle time while the CPU waits for transfer of data to and from the console. *System throughput* is greatly increased with the aid of SPOOLER. Output is never lost due to insufficient memory allocation. Fully compatible with the CP/M file system, SPOOLER permits parallel processing without hardware interrupt, and with minimal impact on other processes. Price: $50.00 (Copyright KLH Systems.)

BASIC-E Compiler

Designed to work with CP/M Disk Operating System this software requires a total of 20K bytes of memory. Included are 26 compiler error messages and 23 run-time error messages. Disk files may be read, written or updated by using both sequential and random access. Included are blocked and unblocked files. Price for compiler and run-time monitor on diskette is $10.00. Manual is available separately for $5.00. (Public domain software by Gordon E. Eubanks, Jr.).

CBASIC Programming System

Upward compatible from BASIC-E, CBASIC is similar but expanded to include several business oriented facilities, allowing decimal computations to 14 digits of precision, data formatting and PRINT USING statements. Statements allow access to disk files and disk file maintenance. Strings of characters may be read from the console to permit correct input line format to be checked before reading data. General programming features include variable names up to 31 characters, optional line numbers, dynamic debugging tracers, and optional data output to printer. CBASIC on diskette and manual priced at $100. (Copyright Software Systems.)

EMPL-an 8080 APL

Especially suited to educational applications, EMPL is an adaptation of APL, using the ASCII character set. This 8K version occupies the first 5376 bytes of memory and operates in two modes. The Execution Mode permits all instructions to be executed immediately. The Definition Mode permits the user to enter functions. EMPL on Tarbell Cassette with manual is $15.00. (Copyright 1977 Erik Mueller).

Tarbell Electronics

T11

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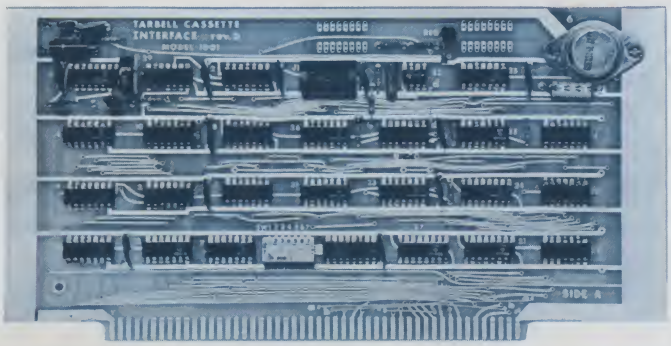
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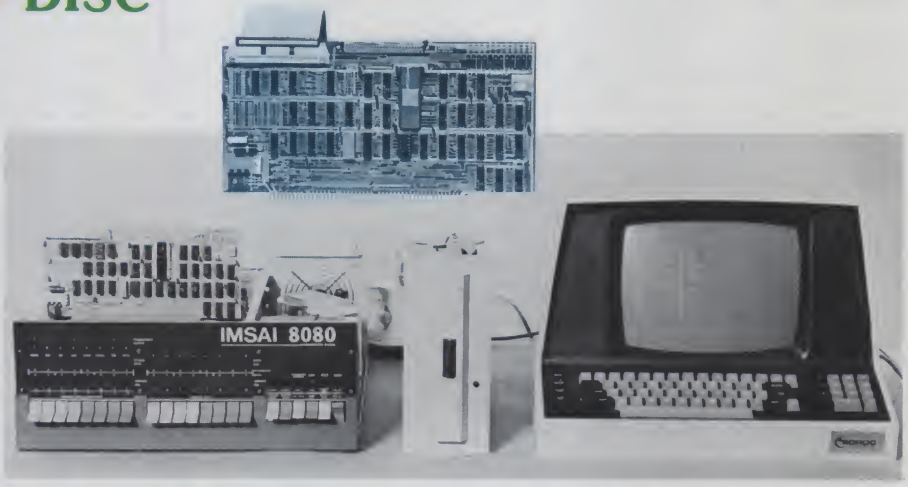


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Do It with a Kimsi!

What's this—S-100 boards with a KIM? Forethought Products makes it easy.

Rick Grossman
4007 Constellation Rd.
Lompoc CA 93436

In the realm of microprocessors the name of the game seems to be expansion! An expanded system allows the user to incorporate the additional memory required to run the more sophisticated programs that are available for KIM, such as Microsoft BASIC or an assembler.

After owning a KIM for over a year, I finally got bit by the expansion bug. I wanted to run BASIC and add a video display system. The cost of the expansion and the boards required was an important factor since I have a multitude of expensive hobbies and I wish to remain in the good graces of the lovely girl to whom I am married. The price of the motherboard and power supply required for the additional memory was, of course, important. A greater consideration was the cost of the boards that were going to be used to expand the system.

After reading the advertisements in various magazines and comparing prices of memory boards, I decided to go with the S-100 bus. The popularity of the S-100 bus will continue to bring the prices down in the future as more companies are attracted to this lucrative market. The best overall expansion system appears to be the Kimsi, which provides the required interface circuitry along with memory decoding that allows use of KIM's 1K of on-board memory. It also allows use of most of the S-100 boards currently available and provides regulation for the 5 volt and 12 volt power for KIM.

The Kimsi kit sells for $125 and goes together with relative ease. There are no MOS or CMOS integrated circuits that are easily damaged by static electricity. All of the integrated circuits are socketed, and the board has a solder mask on the foil side to help prevent solder bridges between the runs. These factors and a complete instruction manual make for easy assembly of the board. The system was functional in about three hours.

The Kimsi motherboard is delivered with one S-100 connector and has provisions for seven more. A word of caution about the installation of the connector: Make sure it is seated properly against the motherboard before you solder it in place. If it is installed incorrectly, it is all but impossible to fix. It should also be noted at this point that the Kimsi board must be insulated from the metal frame if installed in a cabinet. This is done by installing insulated extruded washers on the mounting screws that fasten the Kimsi board to the case.

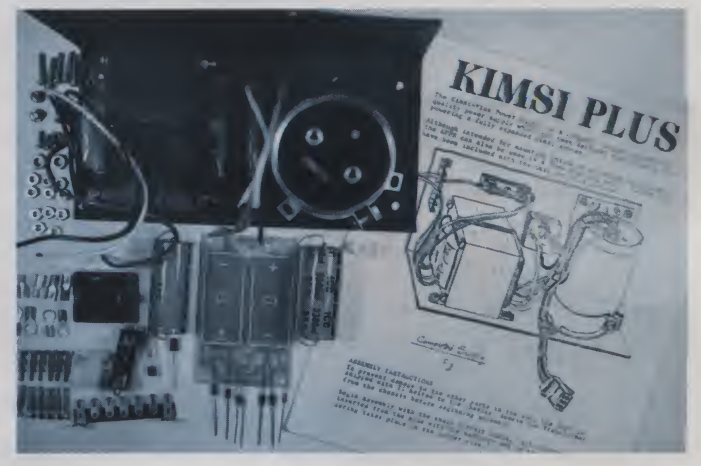
The Kimsi Plus power supply is an excellent addition to the system. Of course, a power supply could be built to power the S-100 system, but this unit in kit form at $69.50 is really a good investment. The supply is an open frame type and is designed so the physical height is the same as the total height of the Kimsi with the standard S-100 board installed.

The power supply is quite hefty, capable of supplying +8 V dc at 10 Amps, +16 volts at 1 Amp and −16 volts at 1 Amp. The transformer is capable of 16 Amps, and the 30 Amp rectifier delivers full power output without forced-air cooling. Previously, KIM was running on a home-brew supply that put out +5 volts at 2 Amps and +12 volts at about 1 Amp.

I encountered considerable difficulty getting the tape to load and dump. Addition of the Kimsi Plus power supply completely solved the problems. The power supply, like the Kimsi, is easy to build. I suggest that when wiring the power supply connector, you use large



1. Kimsi interface/motherboard kit.



2. Kimsi Plus power supply kit.

enough wire on the +8 volt line to handle at least 8 Amps. This allows for additional boards to be installed in the future.

Two methods can be used to connect KIM to Kimsi—either directly through two 22/44 pin connectors, soldered back to back, or by a ribbon cable with 22/44 connectors soldered to each end. There are two more connections to be made—the decode enable signal and the +12 volt supply for tape operation, which is made from the expansion connector to the application connector on the KIM board. I found the cleanest way to jumper these connections was to hard-wire pins 19 and 20 on the expansion connector to k and n on the application connector of the KIM board. I initially used a ribbon cable to connect the KIM to Kimsi and constructed one about ten inches long with connectors on each end.

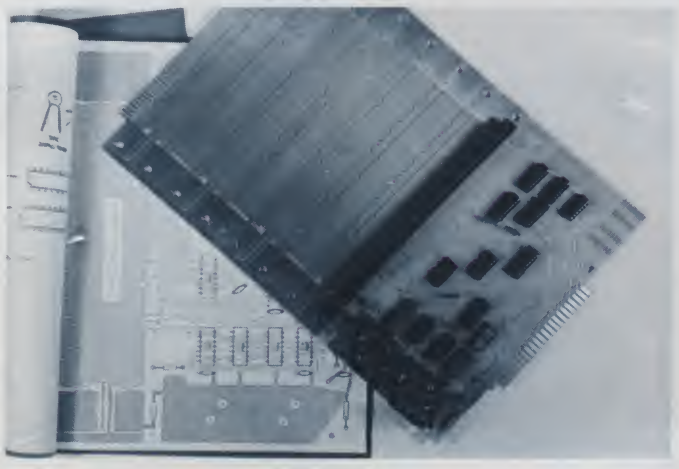
When I brought up the system and tried to run the memory/cable test program supplied in Kimsi documentation, the Vector Graphic 8K memory board I had installed did not pass the test. The cable was then shortened to five inches, and the test ran perfectly. This was necessary because there is no buffering in the Kimsi of the address and data lines going to KIM. Excessive cable length may cause crosstalk and interfere with the data transmission. The other problem that may occur is propagation delay.

Propagation delay will cause the signals arriving at the CPU to be slowed down so they do not arrive in time for proper processing. This problem is a function of cable length, the timing tolerance of the CPU and the crystal frequency tolerance in KIM. The Kimsi instruction manual suggests lowering the frequency of the clock from 1 MHz to approximately 980 kHz to alleviate the problem when exceedingly long cables are used. The frequency of the clock in KIM could be changed by using a crystal with a lower frequency or installing an RC network instead of the crystal as illustrated on page 43 of the KIM hardware manual.

The Kimsi and Kimsi Plus power supply will provide the flexibility of the S-100 bus combined with the advantages of the 6502 processor to make for an excellent low-priced system. The entire cost for this system, which includes KIM, Kimsi, Kimsi Plus power supply, videomonitor, 8K memory, video board and keyboard, is less than $1000. This may seem to be a little more expensive than a PET or Radio Shack system. However, the number and different types of S-100 boards available provide a versatile microprocessor system.

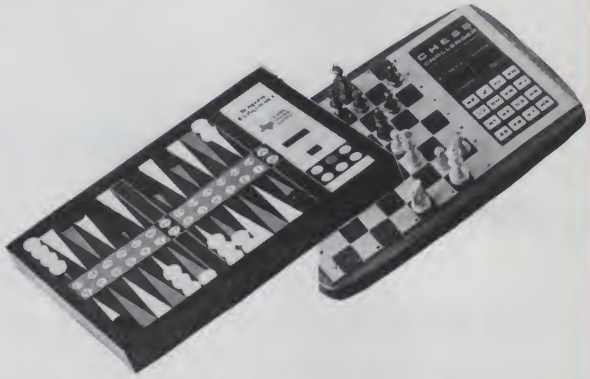
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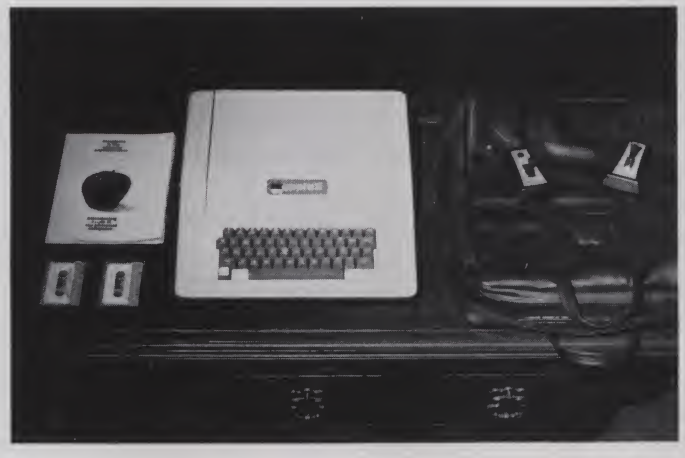
The Remarkable Apple-II

Owners of the Apple computer already know that theirs is a fine machine. This happy Apple-II owner has some things to say that may convince the rest of you.

In 1976, after many years of dreaming about it, I finally got my first personal computer. At that time, a rather unknown little company by the name of Apple Computer advertised their Apple-I system for $666.66. It consisted of a 6502 microprocessor, 4K bytes of RAM, power supply and all the other necessary electronics. But most important, it came fully assembled.

I phoned the company to inquire about ordering an Apple-I. It was during this phone conversation that I was told of their upcoming Apple-II computer, a system that would display not only alphanumerics, but also color and high-resolution graphics! But this new computer was not scheduled to be marketed until around November 1976, so I began playing the waiting game.

Then, around late September, I received word that, because of difficulties, the Apple-II would not become available until sometime in 1977. Tired of waiting, I went ahead and bought an Apple-I. Later, in the summer of 1977, when the Apple-II became available, I was able to receive a fair trade-in allowance on my Apple-I system towards the purchase of an Apple-II.



The Hardware

Probably the most impressive feature of the Apple-II computer is its color-graphics capability. This graphics mode can be operated either as a 40 x 40 element display with room at the bottom of the TV screen for four lines of text, or as a 40 x 48 element display with no text. Each raster element can be set to any one of 16 colors. Since the color-graphics display buffer coincides with the text buffer (hex 0400 to about 07FF), a system with as little memory as 4K can utilize this color-graphics feature.

In addition to this 16-color low-resolution graphics, the Apple-II also has four-color (black, white, green and purple) higher-resolution graphics. (It was actually this HIRES (high resolution) graphics capability, not the LORES color graphics, that prompted me to get an Apple-II.)

As with the lower-resolution 16-color graphics mode, the HIRES graphics can be operated either with space for four lines of text at the bottom of the TV screen or with no text. Since HIRES graphics requires almost 8K bytes for the display buffer, it cannot be used effectively with systems having less than 12K bytes of memory. (Actually, 16K minimum is *recommended*.)

In its literature Apple Computer, Inc., says, "... Apple-II can generate a high-resolution (280 H x 192 V) graphics display in four colors...." This statement is somewhat misleading, if not erroneous. It implies that you can generate a 280 x 192 dot display in which each dot can be set to any one of four colors.

Actually, the computer displays 280 x 192 dots, half of which can be either green or black, while the other half can be either purple or black. Thus, on a color TV the resolution is only 140 x 192 with four colors per raster coordinate; on a black-and-white TV, the resolution is 280 x 192 with only two colors (black or white) per raster coordinate.

The Apple-II can, of course, also display text without graphics. In this mode it has a capacity of 24 40-character lines. Text characters can be displayed as either normal video (white on black), inverse video (black on white) or flashing. And since the display is completely under sofware control, text can be placed anywhere on the screen in any order and in any video mode. (The Apple-I, by comparison, only allowed for a slow serial display of normal video and had no graphics capability at all.)

In addition to visual output, the Apple-II has a built-in speaker, which is accessible via software. This is useful for producing games with sound effects, generating computer music, etc.

Also built onto the Apple-II board are eight peripheral board connectors for interfacing to the outside world, and a game-paddle connector capable of handling up to four input paddles. (Two paddles come supplied with the computer system.) The game paddles are, of course, nothing more than potentiometers; but the Apple-II's ability to read resistance values means that you have essentially four built-in A/D converters at your disposal! No other personal computer on the market offers this feature as part of its standard configuration.

The cassette interface,

which is also built right onto the Apple-II board, is capable of 1500 bps. This means you can load or save a 4K byte program in less than 30 seconds. To load a program from tape, connect the line-out (or earphone) jack from the tape recorder to the cassette-in jack on the back of the computer; to save a program on tape, connect the cassette-out jack on the back of the computer to the microphone jack on the recorder. (Note that the line-in jack of the tape recorder is *not* used with the Apple computers. Many dealers who are used to other computers' cassette interfaces often use the wrong jack when recording from an Apple.)

One oversight in the design of the cassette interface is the failure to utilize the remote start/stop jack found on most portable cassette recorders. This implementation would have been useful for data processing, creating and assembling symbolic source code, etc. In other words, it would be nice to be able to read data from an input tape, and then stop the tape while that data is processed.

The Apple-II uses the new 16K dynamic RAM chips. The board contains three rows of memory sockets with eight sockets per row. Thus, the computer has the capacity to hold up to 48K bytes of memory on a single board! In addition, the Apple-II comes with 8K bytes of ROM, which contains the system monitor (2K) and Apple BASIC (6K). Two additional empty ROM sockets are provided for future expansion.

Apple Computer was the first company to produce a computer powered by a small, lightweight switching power supply; most of the other manufacturers' machines have large, bulky power supplies. Consequently, the Apple-II does not even require a cooling fan. In fact, when you take the lid off an Apple-II and look inside, it seems almost empty! By avoiding the use of heavy components and by packaging the unit in a plastic case instead of a steel case, the designers of the Apple-II created a truly portable, lightweight computer.

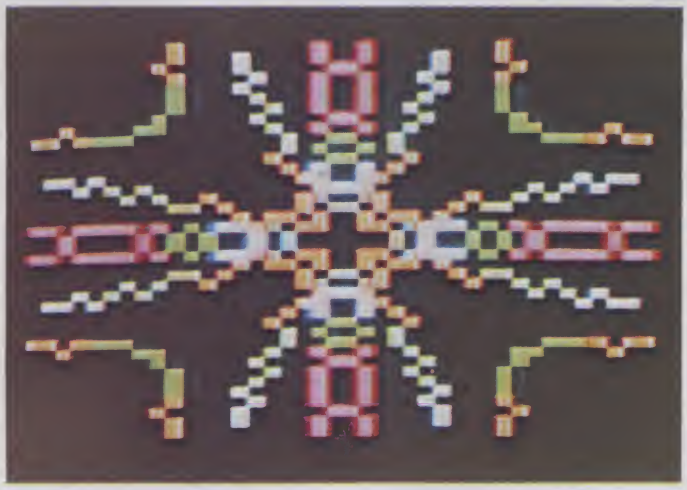
Apple-II Monitor

Besides allowing you to examine and/or modify memory locations (as you'd expect from a monitor), the 2K ROM monitor also contains many other useful features. One of the handiest routines in the monitor is the miniassembler. It allows you to enter an assembly-language program from the keyboard, and assembles it line by line as you type. You must specify all addresses in absolute hex since the miniassembler does not use a symbol table.

Also built into the monitor is a handy disassembler for converting machine code back into mini-assembly language.

To aid in debugging programs, the monitor also has the ability to either single-step through a program or trace the flow of execution while the program is running. Thus, if a program hangs up, you can determine exactly where it is stuck.

The monitor also contains the routines for reading and writing cassette tapes. The timing and formatting of the tape are done with software, not hardware. This means that, given the right software, it should be possible to read or write tapes in almost any format (Kansas City, Tarbell, etc.). However, Apple-II does not use one of the standard formats . . . it uses a format of its own. The cassette routines in the monitor also utilize a checksum to help insure that tapes are read back correctly. The Apple-I firmware did not use a checksum. (When I first pointed out this deficiency, Apple's reply at that time was that their cassette interface was so reliable it didn't need a checksum!)



Example of the low-resolution color-graphics mode.

Apple-II BASIC

The Apple BASIC interpreter is almost legendary as one of the fastest, if not *the* fastest, interpretive languages on any microcomputer. Of course, one of the reasons for its high speed is that it's an integer-only BASIC. But then, there are many applications (like games) that do not require floating-point operations. In fact, Apple BASIC (which is on ROM) and the Apple-II itself are both ideally suited for creating computer games. The paddle controls, the built-in speaker and the exceptional graphics capability make it easy for you to produce arcade-quality video games.

Apple's integer BASIC turns out to have some powerful features, some of which are not usually found in other BASICs. For example, the TRACE command causes each line number to be displayed as it is executed.

Another handy debugging feature is the DSP command, which allows you to see where and how variables become redefined in your program. PEEK and POKE commands allow access to absolute memory locations and are useful for passing arguments to machine-language subroutines (which can be invoked with the CALL command), among other things.

Not surprisingly, Apple BASIC also supports the low-resolution color-graphics capability of the hardware. For example, the PLOT command allows you to plot points, VLIN allows you to draw vertical lines, etc.

What *is* surprising is that the HIRES graphics capability is *not* supported directly. There are no commands in the language to do any HIRES plotting. (This omission, I was told, occurred because the HIRES routines had not yet been completed at the time the ROMs were made. Future versions of Apple BASIC will support the HIRES feature.)

Apple-II Software

In November 1977, Apple Computer released the floating-point BASIC for their Apple-II systems. Written by Microsoft, the same company that wrote Mits BASIC and the BASIC for Commodore's PET computer, Apple's new BASIC (called AppleSoft) now allows the Apple-II to be used for more serious applications than just playing games. The new BASIC is intended for use in business, scientific and educational applications in which decimal numbers must be manipulated.

The AppleSoft BASIC, like the integer BASIC in ROM, also supports the low-resolution color-graphics capability of the Apple-II, while the HIRES graphics is, again, not supported. But this time the omission is understandable since the floating-point BASIC resides in part of the primary HIRES display area and thus cannot be used for graphics. (HIRES graphics *is* possible with the floating-point BASIC if your Apple-II has at least 24K bytes of memory. But you must call separate machine-language subroutines.)

This HIRES graphics problem is currently being worked on at Apple, and a *new* floating-

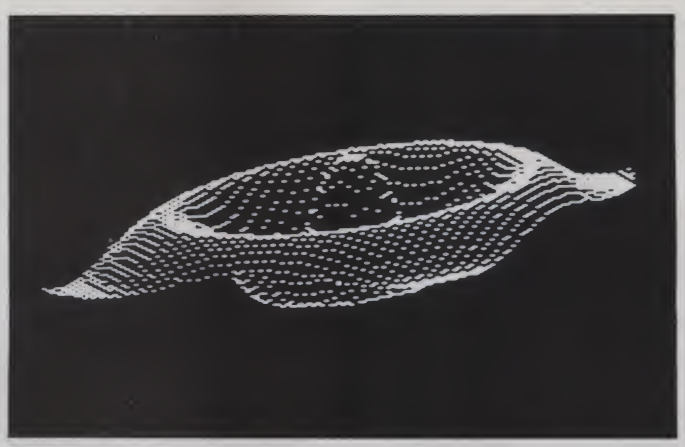
point BASIC that doesn't have the memory conflict may soon be coming out.

Because they are interpretive languages, all BASICs, including Apple's integer BASIC, are relatively slow. Sometimes it is necessary to produce code that executes as quickly as possible. For these applications the Apple-II has, as part of the system monitor, a miniassembler that is very useful for writing small machine-language programs.

What about writing *large* machine-language programs? Yes, you can also use the miniassembler to produce big programs (it's a lot better than assembling them by hand!). But the main problem with a miniassembler (not just Apple's) occurs when you have to insert new code in the middle of an already existing program. Your only resort is to patch in the changes (i.e., insert a JUMP instruction to some other part of memory containing the needed code, and then return). This tends to produce confusing program flow.

Assemblers are usually written for microcomputers with source code read from one input tape and object code written onto another output tape. But the Apple-II only supports one cassette unit, which cannot be started or stopped under software control.

To get around this problem, it is necessary to store the source code and/or object code in memory, along with the assembler itself. This approach has actually been used; text editors/assemblers for the Apple-II are currently available from several sources. (I have recently modified Microsoftware Specialists' ASSM/TED program for the KIM to run on the Apple-II. Copies of this modified program are available from: Microproducts, Hermosa Beach CA, (213) 374-1673.)



Example of the high-resolution graphics mode.

As more and more Apples get around, more and more Apple software will appear, especially games and applications software. Apple has started a new service called the Apple Software Bank from which Apple owners can receive documented and tested software. And if you've written a worthwhile program, you can submit it to the Bank for others to use.

Apple-II vs the Competition

The Apple-II computer comes completely assembled in an attractive plastic case with a full ASCII keyboard. A vinyl carrying case is also supplied with the unit for ease of portability. Since the machine is easy for almost anyone to set up and use, the Apple-II just might become the leading "appliance" computer of the future.

The original price of an Apple-II, complete with 4K bytes of RAM, was around $1300. In the early days of personal computing, a system like the Apple-II at this price would have been a fantastic bargain. For many years B.C. (Before Commodore), computer *kits* with much less capability than the Apple-II were selling for much more money.

But as we enter the era of cheap computing, the pricing standards of yesterday are becoming obsolete. At least two companies (Commodore and Radio Shack) are each offering completely assembled 4K appliance computers for about $600. Although this price includes both a cassette tape recorder and black-and-white TV display, neither system offers color or high-resolution graphics (however, Radio Shack says they plan to offer a similar capability sometime this year at an additional cost).

Furthermore, both companies seem to be having problems in actually delivering their machines—each is quoting a three-to-four-month waiting period. But you can get an Apple-II *right now*; and with it you'll get a good set of useful documentation.

In early 1978, the price of a 4K Apple-II was lowered to $995. Although this is still a little higher than the price of a PET, you get a lot more computer for your money. I bought my Apple-II (serial number 0013) at the higher original price, but I've never regretted it. Now that the price has been lowered to below $1000, there's no excuse for not getting an Apple-II of your own!■

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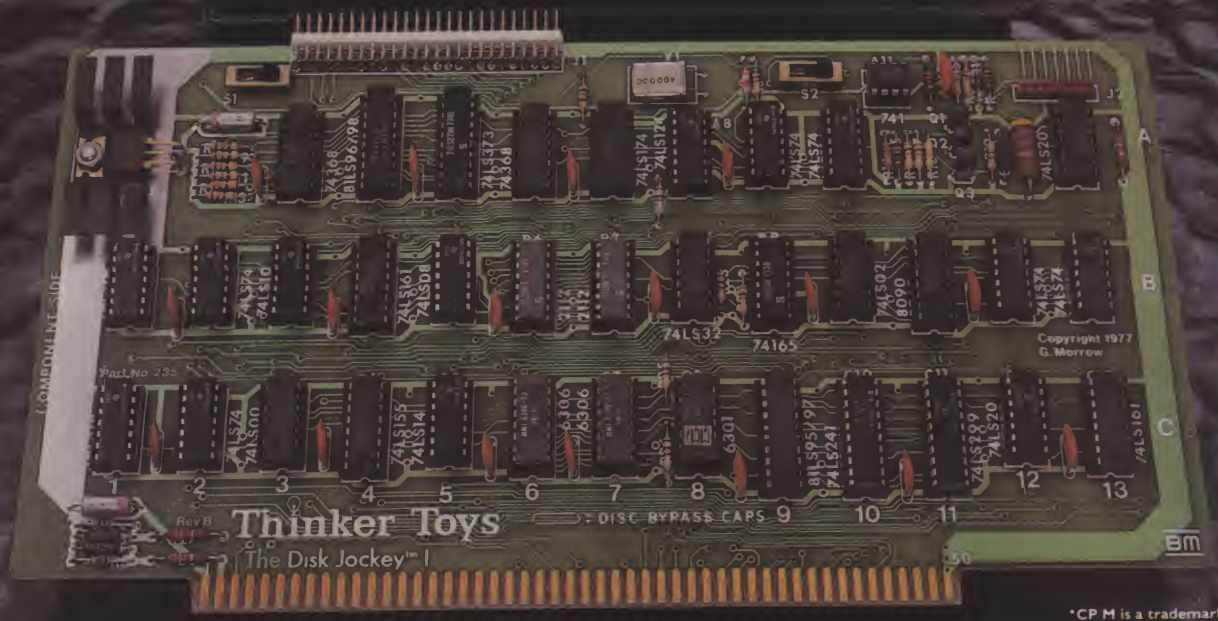
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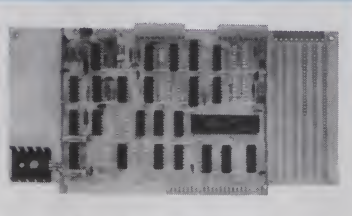


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P7

Universal Number Converter

This program makes a dandy hex-decimal-octal-binary converter, but that's not all. It can also serve as a fine device for teaching people about other number bases.

Easton Beymer
PO Box 2821
Huntsville TX 77341

While in the process of writing a cross-assembler for the MOS Technology 6502 processor, I found it necessary to design a routine for the conversion of decimal, octal and binary numbers into hexadecimal notation. After studying the problem, I noted that a common routine could be written for converting numbers in all three bases into hexadecimal.

The program in this article, written in Commodore PET BASIC, is an outgrowth of my efforts in providing the desired commonality in my cross-assembler. In addition, it includes the capability of converting any number of base 2 to base 16 to any other base-2-to-16 number. The upper limit as to the size of the number that can be converted is strictly a function of the number size allowed by the BASIC interpreter used. In the case of the PET, it is limited to 999,999,999, or the number of characters input before the automatic line feed/carriage return occurs.

Although there seems to be little use in converting a base-5 number to base 13, for example, the capability is there as an outgrowth of the design. However, the unrestricted movement between octal, decimal, hexadecimal and binary should be useful to anyone working on a machine-language or assembly-language level.

The program can be used as a stand-alone routine for general purpose use or as a teaching tool to show the relationships between the different number bases. Also, the driver or mainline portion of the program can be discarded, and the base conversion subroutine used in applications such as disassemblers, cross-assemblers, and memory dump routines where processing speed is not particularly important. ■

```
100 REM * BASE CONVERSION ROUTINE *
110 REM    WRITTEN BY EASTON BEYMER
150 PRINT
200 INPUT "INPUT BASE"; BI%
210 IF BI%<2 OR BI%>16 THEN 600
220 INPUT "INPUT NUMBER"; NI$
300 INPUT "OUTPUT BASE"; BO%
310 IF BO%<2 OR BO%>16 THEN 600
400 GOSUB 10000
410 PRINT "OUTPUT NUMBER="; NO$
500 GO TO 150
600 PRINT "BASE NOT IN RANGE";
610 PRINT " OF 2 TO 16"
700 GO TO 150
10000 REM BASE CONVERSION SUBROUTINE
10100 REM CONVERT TO DECIMAL
10150 L%=LEN(NI$)
10200 DEC=0
10300 PWR%=0
10400 FOR J=L% TO 1 STEP -1
10500   K%=ASC(MID$(NI$,J,1))
10700   IF K%>64 THEN K%=K%-7
10800   K%=K%-48
10810   IF K%<BI% AND K%>-1 THEN 10900
10820     PRINT "INVALID INPUT FOR BASE";
10830     PRINT BI%
10840     NO$="????"
10850     RETURN
10900   DEC=DEC+K%*BI%↑PWR%
11000   PWR%=PWR%+1
11100 NEXT J
11110 REM CONVERT DECIMAL TO BASE #
11120 H$="0123456789ABCDEF"
11130 NO$=""
11200 PWR%=LOG(DEC)/LOG(BO%)
11300 FOR J=PWR% TO 0 STEP -1
11310   XX=INT(BO%↑J)
11320   CH%=DEC/XX
11500   NO$=NO$+MID$(H$,CH%+1,1)
11600   DEC=INT(DEC-CH%*XX)
11700 NEXT J
11800 RETURN
11900 END
```

Program listing.

```
INPUT BASE? 16
INPUT NUMBER? FFFF
OUTPUT BASE? 10
OUTPUT NUMBER=65535

INPUT BASE? 10
INPUT NUMBER? 65535
OUTPUT BASE? 8
OUTPUT NUMBER=177777

INPUT BASE? 8
INPUT NUMBER? 177777
OUTPUT BASE? 2
OUTPUT NUMBER=1111111111111111

INPUT BASE? 5
INPUT NUMBER? 345
OUTPUT BASE? 13
INVALID INPUT FOR BASE 5
OUTPUT NUMBER=????

INPUT BASE? 5
INPUT NUMBER? 344
OUTPUT BASE? 13
OUTPUT NUMBER=78

INPUT BASE? 13
INPUT NUMBER? 78
OUTPUT BASE? 5
OUTPUT NUMBER=344

INPUT BASE? 17
BASE NOT IN RANGE OF 2 TO 16

INPUT BASE? 16
INPUT NUMBER? ABCD
OUTPUT BASE? 2
OUTPUT NUMBER=1010101111001101

INPUT BASE? 2
INPUT NUMBER? 1010101111001101
OUTPUT BASE? 8
OUTPUT NUMBER=125715

INPUT BASE? 8
INPUT NUMBER? 125715
OUTPUT BASE? 10
OUTPUT NUMBER=43981

INPUT BASE? 10
INPUT NUMBER? 43981
OUTPUT BASE? 16
OUTPUT NUMBER=ABCD
```

Sample run.

Cal R. Rasmussen
175 8th St.
Idaho Falls ID 83401

Hexadecimal Memory Dump



One good article generates another. This is a nice companion to one of last year's.

Kudos to Mark Borgerson. His 6800 assembly-language program for fast loading machine-language programs as it appeared in the February 1977 issue of *Kilobaud* ("Cut 6800 Programming Time with this Extraordinary Program," p. 104) works extremely well. I reassembled that program to relocate it to a convenient location in my memory.

After implementing the loader program, it appeared that a hexadecimal dump program would be a very useful companion program. The MIKBUG P command can be used for that purpose; however, it has two disadvantages. First, it is necessary to use the M command to enter the starting and ending addresses at A002-A004. The second, and more serious, disadvantage is that the output is formatted for the MIKBUG tape punch and is very difficult to read since there is no spacing between bytes.

Here is a program that overcomes those disadvantages. The display format is not new, by any means, but the only program I have seen for this format is written to run on an Altair 680b by Mits. Since Mits does not use MIKBUG, the program will not run on my SWTP 6800 system. My program will run

Program listing.

```
00001                        NAM    HEXDUMP
00002                  **
00003                  * HEXADECIMAL MEMORY DUMP PROGRAM
00004                  **
00005                  * LOAD VIA MIKBUG "L" COMMAND
00006                  * USE MIKBUG "G" COMMAND TO START
00007                  **
00008                  * ENTER ADDRESS OF FIRST BYTE TO DUMP
00009                  **
00010                  * ENTER ADDRESS OF LAST BYTE TO DUMP
00011                  **
00012                  * PUSH "RESET" ON COMPUTER TO ABORT
00013                  * CONTROL RETURNS TO MIKBUG
00014                  **
00015                        OPT    NOG
00016                        OPT    S
00017                        OPT    O


00019                  * MIKBUG ROUTINES USED
00020       E1D1       OUTEEE EQU    $E1D1
00021       E0BF       OUT2H  EQU    $E0BF
00022       E047       BADDR  EQU    $E047
00023       E0CC       OUTS   EQU    $E0CC
00024       E0C8       OUT4HS EQU    $E0C8
00025       E0E3       MONIT  EQU    $E0E3


00027                  * START PROGRAM
00028 3F20                    ORG    $3F20
00029 3F20 0002        TEMP   RMB    2          TEMP STORAGE FOR X REG.
00030 3F22 0002        LSTBYT RMB    2          ADDRESS OF LAST BYTE TO DUMP
00031 3F24 0001        COUNT  RMB    1          COLUMN COUNTER
```

on any 6800 system using MIKBUG, or one of the newer replacements for MIKBUG.

I have used the same basic dump technique as in the Altair program, but with input/output routines modified for MIKBUG. I have added some prompt messages at the beginning and have used Mr. Borgerson's technique of relocating the stack pointer to restart the program by simply typing G on the terminal.

To use the program after loading, set the program counter at A048-A049 to 3F25 (or the appropriate starting address if you have relocated the program) and use the MIKBUG G command to start execution. The program title will be printed, followed by a prompt message, FIRST BYTE TO PRINT. The address of the first byte to dump is entered and the computer responds with LAST BYTE TO PRINT. The address of the last byte is entered and the dump begins. The display format consists of 16 bytes per line with the address of the first byte being printed at the left (see Fig. 1).

There is no limit to the amount of memory that can be dumped at one time; any number of bytes from one to 65K can be dumped. (Hope you have a lot of paper for the larger numbers!) A word of caution: The address of the first byte to be dumped must be less than that of the last. If this is not the case, *all* memory locations *except* the region between the two addresses will be dumped! If both addresses are the same, only one byte will be displayed.

The dump shown in Fig. 1 is a dump of the dump program itself. This should prove to be a valuable debugging program; especially if your program has "gone to that never-never land known only to CPUs and covered its tracks in the process," to quote another *Kilobaud* author. ■

```
00032 3F25 8E A060 GO      LDS    #$A060    RELOCATE STACK POINTER
00033 3F28 CE 3FB7         LDX    #TITLE    POINT TO 'TITLE' MESS.
00034 3F2B A6 00   AA      LDA A  00,X      GET CHARACTER TO PRINT
00035 3F2D C6 2E           LDA B  #'.       PUT ASCII PERIOD IN B
00036 3F2F 11              CBA              IS CHAR. IN A-REG A PERIOD?
00037 3F30 27 06           BEQ    ADRS1
00038 3F32 BD E1D1         JSR    OUTEEE    PRINT CHAR IN A REG
00039 3F35 08              INX
00040 3F36 20 F3           BRA    AA        LOOP FOR MORE
00041 3F38 86 0D   ADRS1   LDA A  #$0D      CARRIAGE RETURN
00042 3F3A BD E1D1         JSR    OUTEEE
00043 3F3D 86 0A           LDA A  #$0A      LINE FEED
00044 3F3F BD E1D1         JSR    OUTEEE
00045 3F42 86 00           LDA A  #$00      ASCII NULL
00046 3F44 BD E1D1         JSR    OUTEEE
00047 3F47 BD E1D1         JSR    OUTEEE
00048 3F4A CE 3FCF         LDX    #FIRST    POINT TO 'FIRST' MESS.
00049 3F4D A6 00   BB      LDA A  00,X      GET CHAR TO PRINT
00050 3F4F 11              CBA              IS CHAR IN A-REG A PERIOD?
00051 3F50 27 06           BEQ    GET
00052 3F52 BD E1D1         JSR    OUTEEE    PRINT CHAR IN A REG
00053 3F55 08              INX
00054 3F56 20 F5           BRA    BB        LOOP FOR MORE
00055 3F58 8D 51   GET     BSR    GETADR    GET FIRST ADDRESS
00056 3F5A FF 3F20         STX    TEMP      STORE IT
00057 3F5D BD E0CC         JSR    OUTS
00058 3F60 CE 3FE3         LDX    #LAST     POINT TO 'LAST' MESS.
00059 3F63 A6 00   CC      LDA A  00,X      GET CHARACTER TO PRINT
00060 3F65 C6 2E           LDA B  #'.       ASCII PERIOD IN B-REG
00061 3F67 11              CBA              IS CHAR IN A-REG A PERIOD?
00062 3F68 27 06           BEQ    ADRS2
00063 3F6A BD E1D1         JSR    OUTEEE    PRINT CHAR IN A REG
00064 3F6D 08              INX
00065 3F6E 20 F3           BRA    CC        LOOP FOR MORE
00066 3F70 8D 39   ADRS2   BSR    GETADR    GET LAST ADR
00067 3F72 08              INX              ADJUST IT
00068 3F73 FF 3F22         STX    LSTBYT    STORE IT
00069 3F76 FE 3F20         LDX    TEMP      POINT TO FIRST BYTE
00070 3F79 86 0D   CRLF    LDA A  #$0D      SEND CR,LF
00071 3F7B BD E1D1         JSR    OUTEEE
00072 3F7E 86 0A           LDA A  #$0A
00073 3F80 BD E1D1         JSR    OUTEEE
00074 3F83 86 11           LDA A  #17
00075 3F85 B7 3F24         STA A  COUNT     INIT COUNTER
00076 3F88 FF 3F20         STX    TEMP      STORE X REG
00077 3F8B CE 3F20         LDX    #TEMP
00078 3F8E BD E0C8         JSR    OUT4HS    PRINT ADDRESS
00079 3F91 FE 3F20         LDX    TEMP      RESTORE XREG
00080 3F94 7A 3F24 NXTBYT  DEC    COUNT
00081 3F97 27 E0           BEQ    CRLF
00082 3F99 BD E0CC         JSR    OUTS      SEND A SPACE
00083 3F9C A6 00           LDA A  X         BYTE TO A
00084 3F9E BD E0BF         JSR    OUT2H     PRINT IT, & INCREMENT X-REG
00085 3FA1 BC 3F22         CPX    LSTBYT    ARE WE DONE?
00086 3FA4 27 02           BEQ    JMONIT    YES, RETURN TO MIKBUG
00087 3FA6 20 EC           BRA    NXTBYT
00088 3FA8 7E E0E3 JMONIT  JMP    MONIT
00089 3FAB BD E0CC GETADR  JSR    OUTS      SEND SPACE
00090 3FAE 86 3F           LDA A  #'?       SEND QUESTION MARK
00091 3FB0 BD E1D1         JSR    OUTEEE
00092 3FB3 BD E047         JSR    BADDR     GET ADDRESS
00093 3FB6 39              RTS              RETURN

00095 3FB7 48      TITLE   FCC    /HEXADECIMAL MEMORY DUMP./
00096 3FCF 46      FIRST   FCC    /FIRST BYTE TO PRINT./
00097 3FE3 4C      LAST    FCC    /LAST BYTE TO PRINT./


00099 A048                 ORG    $A048
00100 A048 3F20            FDB    $3F20     STARTING ADDRESS IN PROG CTR
00101                      END
OUTEEE E1D1
OUT2H  E0BF
BADDR  E047

OUTS   E0CC
OUT4HS E0C8
MONIT  E0E3
TEMP   3F20
LSTBYT 3F22
COUNT  3F24
GO     3F25
AA     3F2B
ADRS1  3F38
BB     3F4D
GET    3F58
CC     3F63
ADRS2  3F70
CRLF   3F79
NXTBYT 3F94
JMONIT 3FA8
GETADR 3FAB
TITLE  3FB7
FIRST  3FCF
LAST   3FE3

TOTAL ERRORS 00000
```

```
*G HEXADECIMAL MEMORY DUMP
FIRST BYTE TO PRINT ?3F20 LAST BYTE TO PRINT ?3FF5
3F20  3F 20 3F F6 0C 8E A0 60 CE 3F B7 A6 00 C6 2E 11
3F30  27 06 BD E1 D1 08 20 F3 86 0D BD E1 D1 86 0A BD
3F40  E1 D1 86 00 BD E1 D1 BD E1 D1 CE 3F CF A6 00 11
3F50  27 06 BD E1 D1 08 20 F5 8D 51 FF 3F 20 BD E0 CC
3F60  CE 3F E3 A6 00 C6 2E 11 27 06 BD E1 D1 08 20 F3
3F70  8D 39 08 FF 3F 22 FE 3F 20 86 0D BD E1 D1 86 0A
3F80  BD E1 D1 86 11 B7 3F 24 FF 3F 20 CE 3F 20 BD E0
3F90  C8 FE 3F 20 7A 3F 24 27 E0 BD E0 CC A6 00 BD E0
3FA0  BF BC 3F 22 27 02 20 EC 7E E0 E3 BD E0 CC 86 3F
3FB0  BD E1 D1 BD E0 47 39 48 45 58 41 44 45 43 49 4D
3FC0  41 4C 20 4D 45 4D 4F 52 59 20 44 55 4D 50 2E 46
3FD0  49 52 53 54 20 42 59 54 45 20 54 4F 20 50 52 49
3FE0  4E 54 2E 4C 41 53 54 20 42 59 54 45 20 54 4F 20
3FF0  50 52 49 4E 54 2E
*
```

Fig. 1. Dump of the dump.

Douglas A. Schwab
1591 Gerald Ave.
Glendale Heights IL 60137

IC Testing: A Complete System

Here's a valuable addition to any home-brewer/experimenter's test-equipment collection.

How often have you found that the "prime" integrated circuit you so confidently soldered onto your printed-circuit board was bad? Most of us have had this problem from time to time.

In most cases, this frustrating experience could be avoided by testing the integrated circuits before using them. But the commercial IC testers cost many thousands of dollars. Do you simply have to "grin and bear it?" No! . . . if you own even a modest microcomputer system, you already have most of what is needed to test the little devils.

This article describes a low-cost interface that I designed and built for my SWTP 6800 system to do just that. All that is required is the SWTP 6800 system with its terminal, as little as 2K of memory and the IC tester interface. You should be able to duplicate the interface with all new parts for about $50. You won't be able to test the gate delay of an ECL IC, but you will be able to instantly locate most static faults in TTL and DTL ICs.

I wanted to keep the cost and hardware complexity to a minimum. The interface is designed to connect directly to the SWTP 6800 I/O bus. Quite simply, the IC tester interface allows the microcomputer to output logic conditions to the IC being tested and examine its response. With the proper program logic, most gates and clocked devices can be tested.

I chose to limit the size of the IC to be tested to 16 pins or less for my prototype. This number was especially attractive because it fit on a single I/O bus prototype PC board. Most of

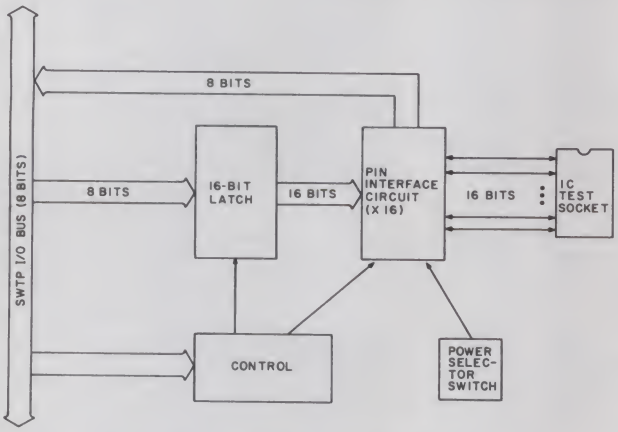


Fig. 1. IC tester block diagram.

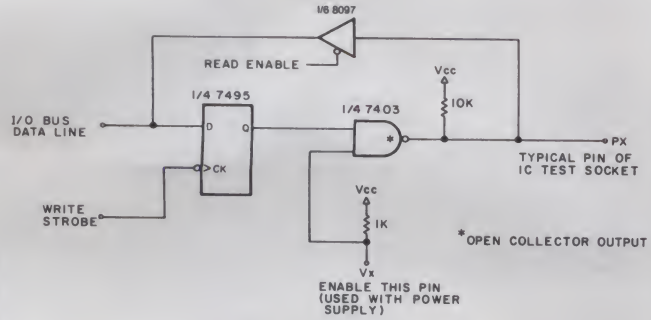
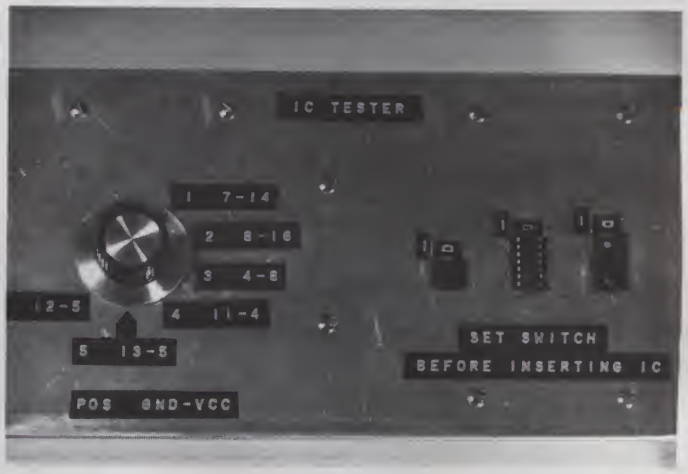


Fig. 2. Pin interface circuit.



IC tester control head.

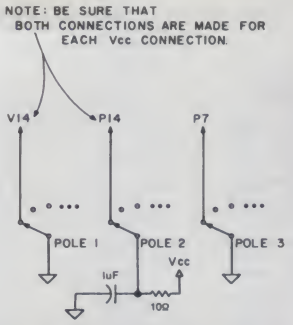
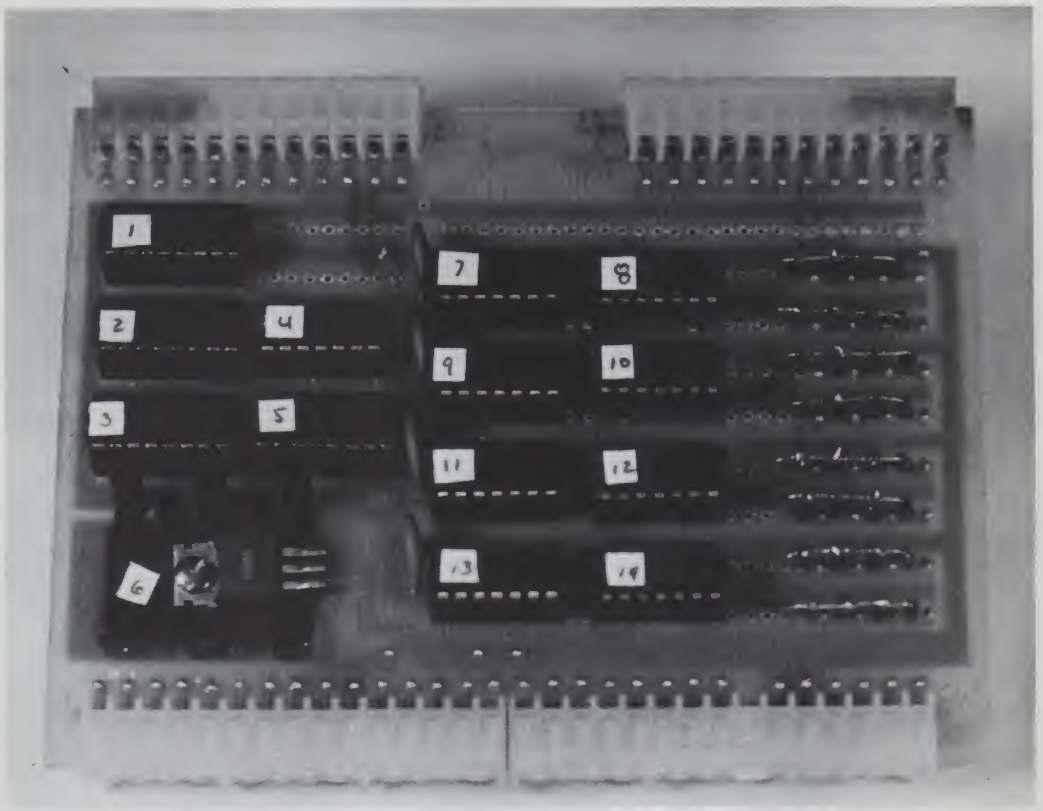


Fig. 3. Power-supply connections for IC test socket.



IC tester interface. (All photos by Diana L. Schwab)

the ICs I wanted to test were 16 pins or less, anyhow. In any case, the basic design can easily be expanded to 32 pins, and, with slightly more trouble, to almost any reasonable size.

Hardware

Fig. 1. shows the general structure of the IC tester. When data is output to the device, it is latched into the 16-bit data latch. The pin interface circuit causes the data to be applied, bit by bit, as logic levels to the IC under test. It also allows logic levels to be read back into the CPU. The logic levels are read and written eight bits at a time, but if the driving program is properly structured, this should not be a problem.

The real heart of this IC tester is the pin interface circuit, which is shown in Fig. 2. This circuit is compatible with DTL, as well as with the popular TTL families (74, 74L, 74S, 74LS, 74H) and standard, open collector or three-state outputs. The typical pin can be an input, output, Vcc or ground connection. The circuit also protects the tester from damage due to either programming or operator error.

When a pin is used as an input, the desired logic condition is simply defined. Output pins should be defined as logical one. Vcc and ground should be defined as logical one and zero, respectively. Pin 1 is always the most significant bit, and pin 16 is the least significant bit of the two-byte constant. Because of an inversion inherent to the pin interface circuit, all data should be ones complemented before being output to the device.

Fig. 3 shows the details of the power supply for the IC being tested. A three-pole, multiposition, nonshorting switch is used to make the power connections. Poles 1 and 3 are grounded, and pole 2 is connected to Vcc through a 10 Ohm resistor. Each switch position corresponds to a ground-Vcc connection pair (e.g., 7-14). For each position, the pole-1 contact is connected directly to the test IC pin to be grounded. The pole-2 contact is connected directly to the pin on which Vcc is to be supplied.

It is essential that, for each connection made to the pole-2 contacts, the corresponding connection be made between the pole-3 contact and the Vx enable for the test pin. This protects the tester against trying to ground a pin connected to Vcc. Fig. 4 is a complete tabulation of the switch connections.

The one remaining part of the hardware is the command decoder. This consists of a single 74S138 and a couple of inverters which provide the clock and enable signals required by the latches and three-state drivers. Decoding is provided to support 16 additional pins, if required. *The "big picture,"* the IC-tester detailed logic diagram, is shown in Fig. 5.

Software Description

I have also written a program to drive the IC tester to test several members of the TTL

```
IC TESTER

IC TYPE NUMBER ?
7400
PWR SEL POS #1
TYPE SPACE TO TEST
IC GOOD

TYPE SPACE TO TEST
IC TYPE NUMBER ?
```

Typical operating sequence.

Switch Position	Gnd-Vcc	Pole 1 Contact	Pole 2 Contact	Pole 3 Contact
1	7-14	P7	P14	V14
2	8-16	P8	P16	V16
3	4-8	P4	P8	V8
4	11-4	P11	P4	V4
5	13-5	P13	P5	V5
6	12-5	P12	P5	V5

Fig. 4. Connections for the ground-Vcc switch.

family. It is a simple program with many possible enhancements. A complete listing is provided in Program A. The program is table-driven, so it is very easy to add new ICs to the list of those that can be tested.

Each IC the tester knows how to test is entered in the catalog. Each catalog entry consists of the eight-character ASCII name of the IC, left-justified and filled with blanks (e.g., 7400 _ _ _ _). The next two bytes contain the address of the truth table used to direct the test. Each entry must be exactly ten bytes, and additional catalog entries may be added immediately before the CATOB label.

The truth tables may vary in length depending on the complexity of the IC being tested. The first byte must always specify the algorithm number. This indicates which test procedure should be used (more on this later). The second byte contains the power-switch position number. The third and fourth bytes contain the 16-bit count of the number of bytes in the remainder of the table.

The remaining bytes in the table contain test data used by the test algorithm; the formats may vary. Three such algorithms are currently defined.

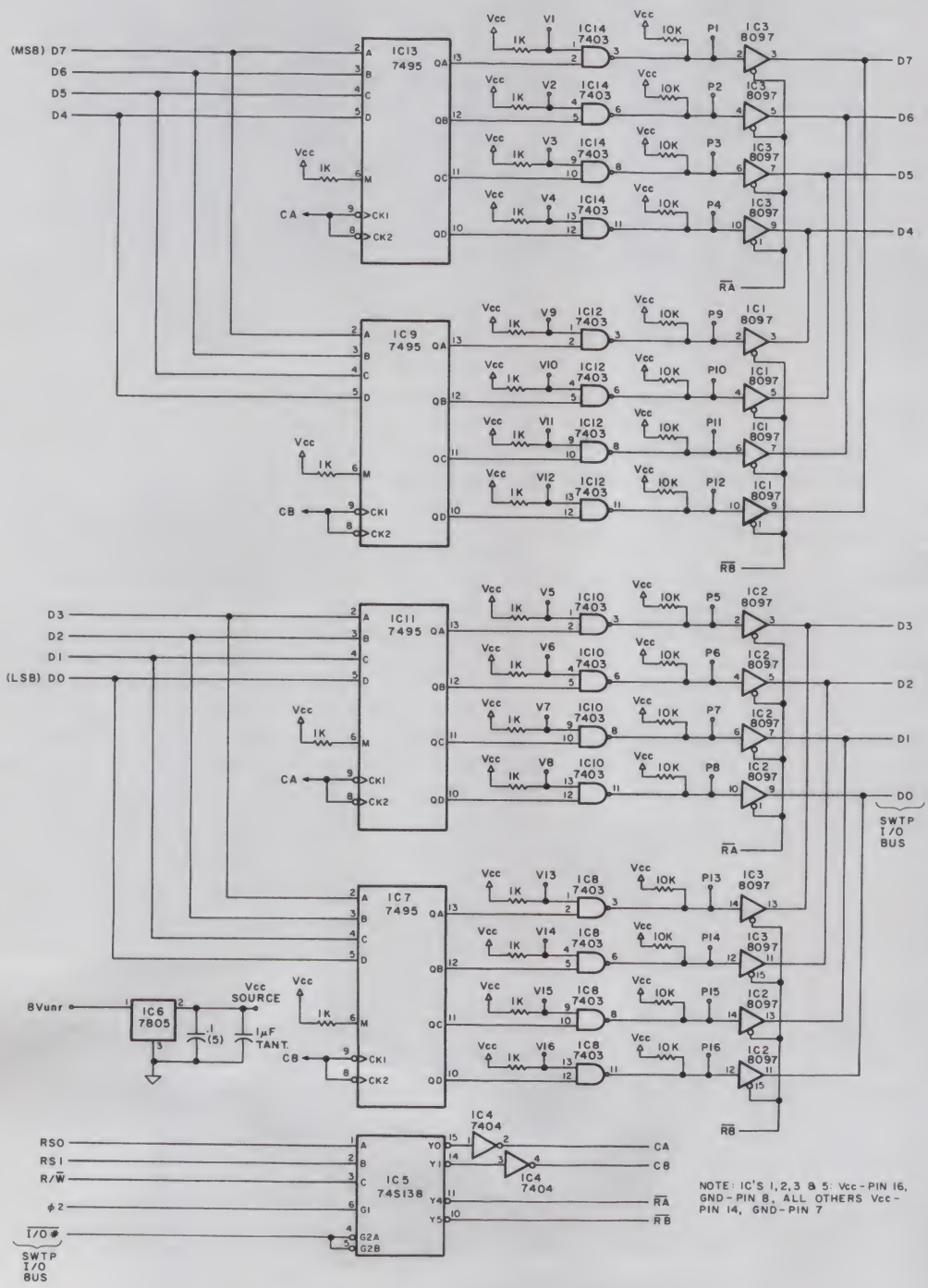


Fig. 5. IC tester—detailed logic diagram.

Algorithm one can be used to test most gates and combinational logic blocks (multiplexers, BCD-to-seven-segment decoders, etc.). The test data for this algorithm is in the following format: two bytes of the desired logic state definitions and two bytes of the proper response. Additional entries are made as required.

Algorithm two can be used to test edge-sensitive devices. These include many flip-flops, shift registers, counters and similar devices. The test data format is two bytes stating definition, two bytes with ones at pins where edge should occur and two bytes of the proper response. Similar entries are repeated as required.

Algorithm three tests pulse-sensitive devices, such as latches and memories. It is the same as algorithm two except that after the edges occur the bits are returned to their original conditions.

So far I have found no easy way to define the truth tables; I have simply drawn the logic elements at the top of a page and filled in ones and zeros in columns below them. There has to be a better way. I hope someone will write some sort of compiler or interpreter that will allow the IC to be described in terms of logical function, and drive the actual test.

Don't forget that some shortcuts are possible without drastically degrading the quality of the test. For instance, all four gates in a 7400 may be tested at the same time. Also, as long as each input pin is tried both high and low, all possible combinations of input pins do not necessarily need to be tried on complex gates and enable circuits.

Operating Considerations

Operating the IC tester is actually very straightforward.

1. When the system prompts with "Enter type number?" enter the IC-type number followed by a carriage return. (Control 0 will back-space one character, while Control X will delete the entire entry.)

2. Set the power-selector switch to the indicated position

and place the IC to be tested in the proper test socket. Type a space to start the test.

3. Read the test results.
4. Additional ICs of the same type may be tested by placing them in the test socket and typing a space. To change to another type, type carriage return and proceed as above.

A couple of operating cautions are in order. The Vcc-ground switch should always be set before inserting the IC. The IC tester is protected from operation error, but the IC being tested is not. No external connections should ever be made to the IC tester or the test socket.

Conclusion

So there it is . . . the IC tester! For a small investment of time and money, you can have a useful and versatile test instrument. And, best of all, when someone gestures at your pride and joy and asks, "But what can it *really* do?" you can show him! ■

Program A. Complete program listing.

```
00010                    NAM    ICTESTER
00020                    OPT    O
00030                ****************
00040                *
00050                *  ICTESTER
00060                *  VERSION 1.2.4
00070                *
00080                ****************

00100 A048                    ORG    $A048
00110 A048 0100               FDB    XFERA

00130 0080                    ORG    $80
00140                   CONSTANTS, VARIABLES, ETC.
00150 0080 00        CTR1     FCB    0
00160 0081 0000      CTR2     FDB    0
00170 0083 0000      PTR1     FDB    0
00180 0085 0000      PTR2     FDB    0
00190 0087 00        TEMP1    FCB    0
00200 0088 0000      XRSAV    FDB    0
00210 008A 00        ALGNO    FCB    0          CURRENT ALGORITHM NUMBER
00220 008B 0000      CATPR    FDB    0          CATALOG ENTRY POINTER
00230 008D 0000      TRTBL    FDB    0          TRUTH TBL POINTER
00240 008F 00        PASS     FCB    0          RE-TEST CTR
00250 0090 00        PWRSW    FCB    0          CURRENT PWR SW POS
00260 0091 800C      APORT    FDB    $800C      ADDRESS OF ICTESTER CARD

00280      000A      TBSIZ    EQU    10         INPUT BUFFER BYTE SIZE
00290 0093 000C      TEMPBF   RMB    TBSIZ+2

00310 0100                    ORG    $100
00320      0100      XFERA    EQU    *          TRANSFER ADDRESS
00330 0100 7E 0103            JMP    *+3        HARDSTART = SOFTSTART
00340 0103 CE 0220            LDX    #TXT010    PRINT GREETING
00350 0106 BD E07E            JSR    PDATA1
00360      0109      RDTYP    EQU    *          RD NEXT TYPE NO
00370 0109 CE 0231            LDX    #TXT020    ASK FOR TYPE NUMBER
00380 010C BD E07E            JSR    PDATA1
00390      010F      READ     EQU    *          READ TYPE NUMBER
00400 010F 86 0A              LDA A  #TBSIZ
00410 0111 97 80              STA A  CTR1
00420 0113 CE 0093            LDX    #TEMPBF
00430 0116 DF 83              STX    PTR1
00440 0118 C6 20              LDA B  #$20       FILL WITH BLANKS
00450      011A      LOOP1    EQU    *
00460 011A E7 00              STA B  0,X
00470 011C 08                 INX
00480 011D 4A                 DEC A
00490 011E 26 FA              BNE    LOOP1
00500      0120      READ1    EQU    *
00510 0120 BD E1AC            JSR    INEEE
00520 0123 81 0D              CMP A  #$0D       TERM ON CR
00530 0125 27 32              BEQ    READ2
00540 0127 81 0F              CMP A  #$0F       CNTL O -BACKSPACE
00550 0129 27 15              BEQ    BKSPC
00560 012B 81 18              CMP A  #$18       CNTL X -DELETE
00570 012D 27 DA              BEQ    RDTYP
00580 012F 7D 0080            TST    CTR1
00590 0132 27 EC              BEQ    READ1
00600 0134 DE 83              LDX    PTR1
00610 0136 A7 00              STA A  0,X
00620 0138 08                 INX
00630 0139 DF 83              STX    PTR1
00640 013B 7A 0080            DEC    CTR1
00650 013E 20 E0              BRA    READ1
00660      0140      BKSPC    EQU    *
00670 0140 96 80              LDA A  CTR1
00680 0142 81 0A              CMP A  #TBSIZ
00690 0144 27 11              BEQ    BKSP1
00700 0146 86 5F              LDA A  #$5F
00710 0148 BD E1D1            JSR    OUTEEE
00720 014B DE 83              LDX    PTR1
00730 014D 09                 DEX
00740 014E 86 20              LDA A  #$20
00750 0150 A7 00              STA A  0,X
00760 0152 DF 83              STX    PTR1
00770 0154 7C 0080            INC    CTR1
00780 0157 20 C7     BKSP1    BRA    READ1

00800      0159      READ2    EQU    *
00810                *  SEARCH CATALOG
00820 0159 CE 0343            LDX    #CATOL     START AT TOP
00830 015C DF 83              STX    PTR1       PTR1=>CAT ENTRY
00840      015E      LOOP3    EQU    *
00850 015E DE 83              LDX    PTR1
00860 0160 DF 8B              STX    CATPR
00870 0162 8C 03F7            CPX    #CATOR
00880 0165 27 7E              BEQ    CATEN

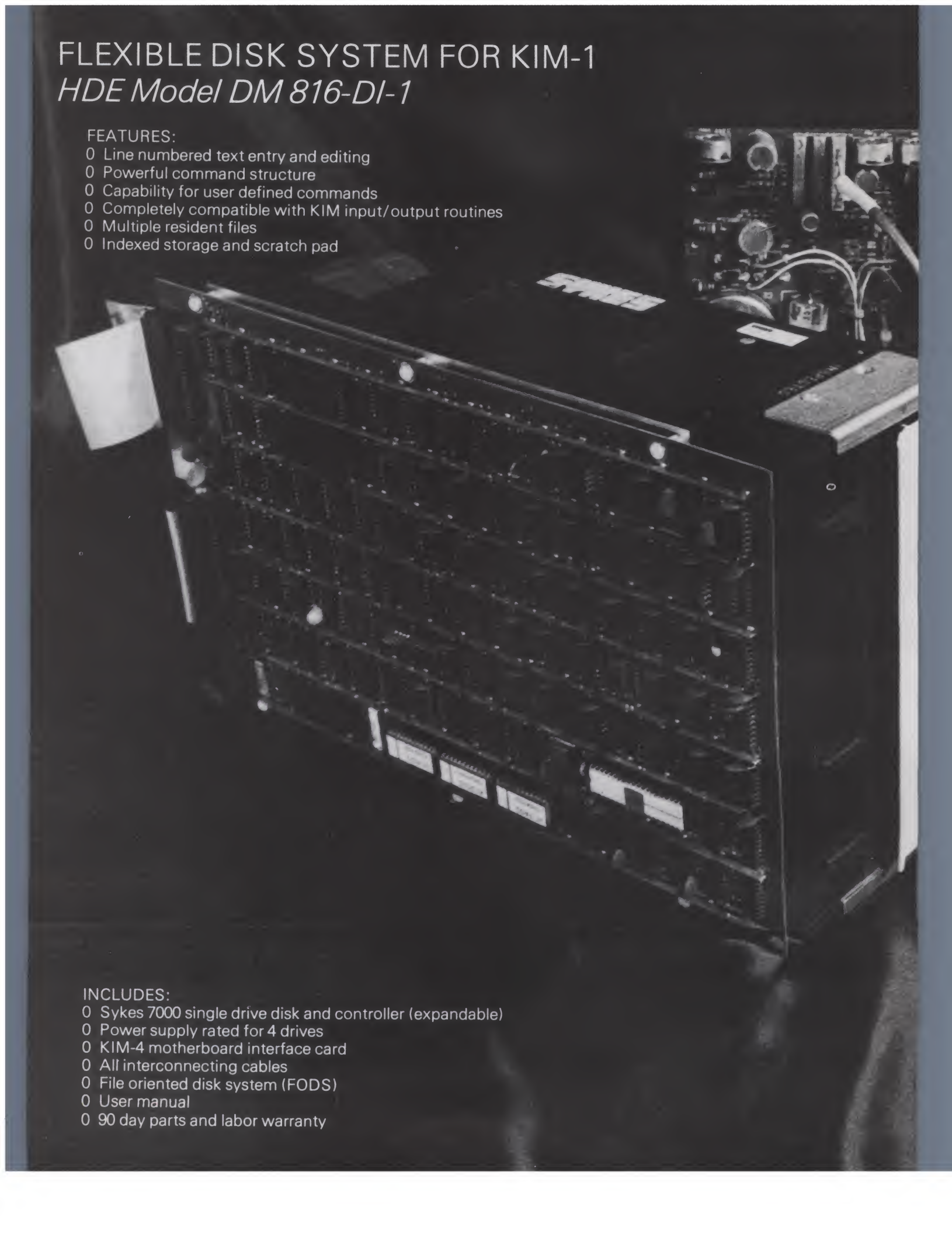
00900 0167 CE 0093            LDX    #TEMPBF    PTR2=> INPUT BUFFER
00910 016A DF 85              STX    PTR2
00920 016C 86 06              LDA A  #6         CTR1= CHAR COUNT
00930 016E 97 80              STA A  CTR1

00950      0170      LOOP2    EQU    *
00960 0170 DE 83              LDX    PTR1
00970 0172 A6 00              LDA A  0,X
00980 0174 DE 85              LDX    PTR2
00990 0176 A1 00              CMP A  0,X
01000 0178 26 0F              BNE    NOMAT
01010 017A 08                 INX
01020 017B DF 85              STX    PTR2
01030 017D DE 83              LDX    PTR1
01040 017F 08                 INX
01050 0180 DF 83              STX    PTR1
01060 0182 7A 0080            DEC    CTR1
01070 0185 26 E9              BNE    LOOP2
01080 0187 20 10              BRA    MATCH      FOUND IT AT LAST

01100      0189      NOMAT    EQU    *          NO MATCH YET
01110 0189 DE 8B              LDX    CATPR      LOOK AT NEXT CAT ENTRY
01120 018B 08                 INX
01130 018C 08                 INX
01140 018D 08                 INX
01150 018E 08                 INX
01160 018F 08                 INX
```

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— SCRATCH PAD(A and B), SAVE
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```
01170 0190 08            INX
01180 0191 08            INX
01190 0192 08            INX
01200 0193 08            INX
01210 0194 08            INX
01220 0195 DF 83         STX     PTR1
01230 0197 20 C5         BRA     LOOP3


01250      0199    MATCH EQU     *          CATALOG ENTRY FOUND
01260 0199 DE 8B         LDX     CATPR
01270 019B EE 08         LDX     8,X
01280 019D DF 8D         STX     TRTBL
01290 019F A6 01         LDA A   1,X        SHOW PWR SW POS
01300 01A1 97 90         STA A   PWRSW
01310 01A3 CE 02A5       LDX     #TXT080
01320 01A6 BD E07E       JSR     PDATA1
01330 01A9 CE 0090       LDX     #PWRSW
01340 01AC BD E0CA       JSR     OUT2HS


01360      01AF    NEXT  EQU     *          TEST NEXT IC
01370 01AF 7F 008F       CLR     PASS
01380 01B2 CE 0290       LDX     #TXT070
01390 01B5 BD E07E       JSR     PDATA1
01400 01B8 BD E1AC       JSR     INEEE
01410 01BB 81 20         CMP A   #$20
01420 01BD 27 03         BEQ     RETST
01430 01BF 7E 0109       JMP     RDTYP
01450      01C2    RETST EQU     *
01460 01C2 DE ED         LDX     TRTBL
01470 01C4 A6 00         LDA A   0,X        GET ALGORITHM NUMBER
01480 01C6 97 8A         STA A   ALGNO      SAVE IT FOR LATER
01490 01C8 81 01         CMP A   #$01       SIMPLE STORE COMPARE
01500 01CA 27 0A         BEQ     ALG01P
01510 01CC 81 02         CMP A   #$02       EDGE DEVICE ALGORITHM
01520 01CE 27 09         BEQ     ALG02P
01530 01D0 81 03         CMP A   #$03       PULSE DEVICE ALGORITHM
01540 01D2 27 08         BEQ     ALG03P
01550               * ADD ALG VECTORS HERE
01560 01D4 20 12         BRA     ERROR
01570 01D6 7E 02B4 ALG01P JMP    ALG01
01580 01D9 7E 02EE ALG02P JMP    ALG02
01590 01DC 7E 02EE ALG03P JMP    ALG03


01610      01DF    CATEN EQU     *          NOT IN CATALOG
01620 01DF CE 025D       LDX     #TXT050
01630 01E2 BD E07E       JSR     PDATA1     PRINT MESSAGE
01640 01E5 7E 0109       JMP     RDTYP


01660      01E8    ERROR EQU     *          SOME ERROR EXISTS
01670 01E8 CE 0270       LDX     #TXT060
01680 01EB BD E07E       JSR     PDATA1     PRINT MESSAGE
01690 01EE 3F            SWI


01710      01EF    PUT   EQU     *          OUTPUT TO IC
01720 01EF DF 88         STX     XRSAV
01730 01F1 DE 91         LDX     APORT
01740 01F3 43            COM A              CORRECT FOR HARDWARE INVERSION
01750 01F4 53            COM B
01760 01F5 A7 00         STA A   0,X
01770 01F7 E7 01         STA B   1,X
01780 01F9 43            COM A
01790 01FA 53            COM B
01800 01FB DE 88         LDX     XRSAV
```

```
           0242 3F
02200      0243 0D            FCB     CR,LF,EOD
           0244 0A
           0245 04
02210      0246 0D      TXT030 FCB     CR,LF
           0247 0A
02220      0248 49            FCC     /IC GOOD/
           0249 43
           024A 20
           024B 47
           024C 4F
           024D 4F
           024E 44
02230      024F 0D            FCB     CR,LF,EOD
           0250 0A
           0251 04
02240      0252 0D      TXT040 FCB     CR,LF
           0253 0A
02250      0254 49            FCC     /IC BAD/
           0255 43
           0256 20
           0257 42
           0258 41
           0259 44
02260      025A 0D            FCB     CR,LF,EOD
           025B 0A
           025C 04
02270      025D 0D      TXT050 FCB     CR,LF
           025E 0A
02280      025F 54            FCC     /TYPE NOT FOUND/
           0260 59
           0261 50
           0262 45
           0263 20
           0264 4E
           0265 4F
           0266 54
           0267 20
           0268 46
           0269 4F
           026A 55
           026B 4E
           026C 44
02290      026D 0D            FCB     CR,LF,EOD
           026E 0A
           026F 04
02300      0270 0D      TXT060 FCB     CR,LF
           0271 0A
02310      0272 2A            FCC     /*** CONTROL TABLE ERROR ***/
           0273 2A
           0274 2A
           0275 20
           0276 43
           0277 4F
           0278 4E
           0279 54
           027A 52
           027B 4F
           027C 4C
           027D 20
           027E 54
           027F 41
           0280 42
           0281 4C
           0282 45
           0283 20
           0284 45
           0285 52
           0286 52
           0287 4F
           0288 52
           0289 20
           028A 2A
```

```
01810 01FD 39            RTS

01830      01FE    GET     EQU   *          INPUT FROM IC
01840 01FE DF 88           STX   XRSAV
01850 0200 DE 91           LDX   APORT
01860 0202 A6 00           LDA A 0,X
01870 0204 E6 01           LDA B 1,X
01880 0206 DE 88           LDX   XRSAV
01890 0208 39              RTS
01910      0209    ICGOOD  EQU   *          IC IS GOOD
01920 0209 7C 008F         INC   PASS       RETEST 255 TIMES
01930 020C 26 B4           BNE   RETST
01940 020E CE 0246         LDX   #TXT030
01950 0211 BD E07E         JSR   PDATA1
01960 0214 7E 01AF         JMP   NEXT


01980      0217    ICBAD   EQU   *          IC IS BAD
01990 0217 CE 0252         LDX   #TXT040
02000 021A BD E07E         JSR   PDATA1
02010 021D 7E 01AF         JMP   NEXT


02030      E07E    PDATA1  EQU   $E07E
02040      E1AC    INEEE   EQU   $E1AC
02050      E1D1    OUTEEE  EQU   $E1D1
02060      E0C8    OUT4HS  EQU   $E0C8
02070      E0CA    OUT2HS  EQU   $E0CA
02080      E0E3    CONTRL  EQU   $E0E3
02090      000D    CR      EQU   $0D
02100      000A    LF      EQU   $0A
02110      0004    EOD     EQU   $04


02130              *  TEXT STRINGS, ETC.
02140 0220 10      TXT010  FCB   $10,$16,CR,LF
      0221 16
      0222 0D
      0223 0A
02150 0224 49              FCC   /IC TESTER/
      0225 43
      0226 20
      0227 54
      0228 45
      0229 53
      022A 54
      022B 45
      022C 52
02160 022D 0D              FCB   CR,LF,LF
      022E 0A
      022F 0A
02170 0230 04              FCB   EOD
02180 0231 0D      TXT020  FCB   CR,LF
      0232 0A
02190 0233 49              FCC   /IC TYPE NUMBER ?/
      0234 43
      0235 20
      0236 54
      0237 59
      0238 50
      0239 45
      023A 20
      023B 4E
      023C 55
      023D 4D
      023E 42
      023F 45
      0240 52
      0241 20
```



```
      028B 2A
      028C 2A
02320 028D 0D              FCB   CR,LF,EOD
      028E 0A
      028F 04
02330 0290 0D      TXT070  FCB   CR,LF
      0291 0A
02340 0292 54              FCC   /TYPE SPACE TO TEST/
      0293 59
      0294 50
      0295 45
      0296 20
      0297 53
      0298 50
      0299 41
      029A 43
      029B 45
      029C 20
      029D 54
      029E 4F
      029F 20
      02A0 54
      02A1 45
      02A2 53
      02A3 54
02350 02A4 04              FCB   EOD
02360 02A5 0D      TXT080  FCB   CR,LF
      02A6 0A
02370 02A7 50              FCC   /PWR SEL POS /
      02A8 57
      02A9 52
      02AA 20
      02AB 53
      02AC 45
      02AD 4C
      02AE 20
      02AF 50
      02B0 4F
      02B1 53
      02B2 20
02380 02B3 04              FCB   EOD
02400      02B4    ALGO1   EQU   *          ALGORITHM TO CHECK GATES
02410 02B4 DE 8D           LDX   TRTBL
02420 02B6 EE 02           LDX   2,X
02430 02B8 DF 81           STX   CTR2
02440 02BA DE 8D           LDX   TRTBL
02450 02BC 08              INX
02460 02BD 08              INX
02470 02BE 08              INX
02480 02BF 08              INX
02490 02C0 DF 83           STX   PTR1
02500      02C2    A01A    EQU   *
02510 02C2 DE 83           LDX   PTR1
02520 02C4 A6 00           LDA A 0,X
02530 02C6 E6 01           LDA B 1,X
02540 02C8 BD 01EF         JSR   PUT
02550 02CB BD 01FE         JSR   GET
02560 02CE DE 83           LDX   PTR1
02570 02D0 A1 02           CMP A 2,X
02580 02D2 26 17           BNE   A01B
02590 02D4 E1 03           CMP B 3,X
02600 02D6 26 13           BNE   A01B
02610 02D8 08              INX
02620 02D9 08              INX
02630 02DA 08              INX
02640 02DB 08              INX
02650 02DC DF 83           STX   PTR1
02660 02DE DE 81           LDX   CTR2
02670 02E0 09              DEX
02680 02E1 09              DEX
02690 02E2 09              DEX
02700 02E3 09              DEX
02710 02E4 DF 81           STX   CTR2
```

```
02720 02E6 26 DA          BNE    A01A
02730      02E8    A01G   EQU    *
02740 02E8 7E 0209        JMP    ICGOOD
02750      02EB    A01B   EQU    *
02760 02EB 7E 0217        JMP    ICBAD
02780      02EE    ALG02  EQU    *          ALG TO CHECK EDGE AND PULSE
02790      02EE    ALG03  EQU    *          SENSITIVE DEVICES
02800 02EE 96 8A          LDA A  ALGNO
02810 02F0 DE 8D          LDX    TRTBL
02820 02F2 4A             DEC A
02830 02F3 4A             DEC A
02840 02F4 97 87          STA A  TEMP1
02850 02F6 EE 02          LDX    2,X
02860 02F8 DF 81          STX    CTR2
02870 02FA DE 8D          LDX    TRTBL
02880 02FC 08             INX
02890 02FD 08             INX
02900 02FE 08             INX
02910 02FF 08             INX
02920 0300 DF 83          STX    PTR1
02930      0302    A02A   EQU    *
02940 0302 DE 83          LDX    PTR1
02950 0304 A6 00          LDA A  0,X
02960 0306 E6 01          LDA B  1,X
02970 0308 BD 01EF        JSR    PUT
02980 030B A8 02          EOR A  2,X
02990 030D E8 03          EOR B  3,X
03000 030F BD 01EF        JSR    PUT
03010 0312 7D 0087        TST    TEMP1
03020 0315 27 07          BEQ    A02B       ALG02 GENERATES EDGE ONLY
03030 0317 A8 02          EOR A  2,X
03040 0319 E8 03          EOR B  3,X
03050 031B BD 01EF        JSR    PUT
03060      031E    A02B   EQU    *
03070 031E BD 01FE        JSR    GET
03080 0321 A1 04          CMP A  4,X
03090 0323 26 1B          BNE    A02D
03100 0325 E1 05          CMP B  5,X
03110 0327 26 17          BNE    A02D
03120 0329 08             INX
03130 032A 08             INX
03140 032B 08             INX
03150 032C 08             INX
03160 032D 08             INX
03170 032E 08             INX
03180 032F DF 83          STX    PTR1
03190 0331 DE 81          LDX    CTR2
03200 0333 09             DEX
03210 0334 09             DEX
03220 0335 09             DEX
03230 0336 09             DEX
03240 0337 09             DEX
03250 0338 09             DEX
03260 0339 DF 81          STX    CTR2
03270 033B 26 C5          BNE    A02A
03280      033D    A02C   EQU    *
03290 033D 7E 0209        JMP    ICGOOD
03300      0340    A02D   EQU    *
03310 0340 7E 0217        JMP    ICBAD
03330                *  CATALOG OF TESTABLE IC'S
03340      0343    CATOL  EQU    *

03360 0343 37             FCC    8,7400
      0344 34
      0345 30
      0346 30
      0347 20
      0348 20
      0349 20
      034A 20
03370 034B 03F7           FDB    TT01

03390 034D 37             FCC    8,7403
      0397 20
      0398 20
      0399 20
      039A 20
03610 039B 041F           FDB    TT03

03630 039D 37             FCC    8,7414
      039E 34
      039F 31
      03A0 34
      03A1 20
      03A2 20
      03A3 20
      03A4 20
03640 03A5 041F           FDB    TT03

03660 03A7 37             FCC    8,7415
      03A8 34
      03A9 31
      03AA 36
      03AB 20
      03AC 20
      03AD 20
      03AE 20
03670 03AF 041F           FDB    TT03

03690 03B1 37             FCC    8,7407
      03B2 34
      03B3 30
      03B4 37
      03B5 20
      03B6 20
      03B7 20
      03B8 20
03700 03B9 042B           FDB    TT04

03720 03BB 37             FCC    8,7420
      03BC 34
      03BD 32
      03BE 30
      03BF 20
      03C0 20
      03C1 20
      03C2 20
03730 03C3 0437           FDB    TT05

03750 03C5 37             FCC    8,7413
      03C6 34
      03C7 31
      03C8 33
      03C9 20
      03CA 20
      03CB 20
      03CC 20
03760 03CD 0437           FDB    TT05

03780 03CF 37             FCC    8,7440
      03D0 34
      03D1 34
      03D2 30
      03D3 20
      03D4 20
      03D5 20
      03D6 20
03790 03D7 0437           FDB    TT05

03810 03D9 37             FCC    8,7474
      03DA 34
      03DB 37
      03DC 34
      03DD 20
      03DE 20
      03DF 20
```

```
                034E 34
                034F 30
                0350 33
                0351 20
                0352 20
                0353 20
                0354 20
03400           0355 03F7           FDB     TT01

03420           0357 37             FCC     8,7426
                0358 34
                0359 32
                035A 36
                035B 20
                035C 20
                035D 20
                035E 20
03430           035F 03F7           FDB     TT01

03450           0361 37             FCC     8,7402
                0362 34
                0363 30
                0364 32
                0365 20
                0366 20
                0367 20
                0368 20
03460           0369 040B           FDB     TT02

03480           036B 37             FCC     8,7428
                036C 34
                036D 32
                036E 38
                036F 20
                0370 20
                0371 20
                0372 20
03490           0373 040B           FDB     TT02

03510           0375 37             FCC     8,7433
                0376 34
                0377 33
                0378 33
                0379 20
                037A 20
                037B 20
                037C 20
03520           037D 040B           FDB     TT02

03540           037F 37             FCC     8,7404
                0380 34
                0381 30
                0382 34
                0383 20
                0384 20
                0385 20
                0386 20
03550           0387 041F           FDB     TT03

03570           0389 37             FCC     8,7405
                038A 34
                038B 30
                038C 35
                038D 20
                038E 20
                038F 20
                0390 20
03580           0391 041F           FDB     TT03

03600           0393 37             FCC     8,7406
                0394 34
                0395 30
                0396 36
```



```
                03E0 20
03820           03E1 0453           FDB     TT06

03840           03E3 37             FCC     8,74S138
                03E4 34
                03E5 53
                03E6 31
                03E7 33
                03E8 38
                03E9 20
                03EA 20
03850           03EB 0475           FDB     TT07

03870           03ED 37             FCC     8,74LS138
                03EE 34
                03EF 4C
                03F0 53
                03F1 31
                03F2 33
                03F3 38
                03F4 20
03880           03F5 0475           FDB     TT07

03900                03F7   CAT0B   EQU     *
03920                03F7   TT01    EQU     *           TRUTH TABLE FOR 7400, ETC.
03930           03F7 01             FCB     $01         ALG NUMBER
03940           03F8 01             FCB     1           POWER SWITCH POS
03950           03F9 0010           FDB     16          BYTE COUNT FOR TEST DATA
03960           03FB 2524           FDB     $2524       (DEFINE) TEST DATA
03970           03FD 2524           FDB     $2524       (COMPARE)
03980           03FF 6D6C           FDB     $6D6C
03990           0401 6D6C           FDB     $6D6C
04000           0403 B5B4           FDB     $B5B4
04010           0405 B5B4           FDB     $B5B4
04020           0407 FDFC           FDB     $FDFC
04030           0409 D8DC           FDB     $D8DC


04050                040B   TT02    EQU     *           TT FOR 7402, ETC.
04060           040B 01             FCB     $01
04070           040C 01             FCB     1
04080           040D 0010           FDB     16
04090           040F 904C           FDB     $904C
04100           0411 904C           FDB     $904C
04110           0413 B4DC           FDB     $B4DC
04120           0415 2494           FDB     $2494
04130           0417 D96C           FDB     $D96C
04140           0419 4924           FDB     $4924
04150           041B FDFC           FDB     $FDFC
04160           041D 6DB4           FDB     $6DB4


04180                041F   TT03    EQU     *           TT FOR 7404, ETC.
04190           041F 01             FCB     1
04200           0420 01             FCB     1
04210           0421 0008           FDB     8
04220           0423 5554           FDB     $5554
04230           0425 5554           FDB     $5554
04240           0427 FDFC           FDB     $FDFC
04250           0429 A8AC           FDB     $A8AC


04270                042B   TT04    EQU     *           TT FOR 7407, ETC.
04280           042B 01             FCB     1
04290           042C 01             FCB     1
04300           042D 0008           FDB     8
04310           042F 5554           FDB     $5554
04320           0431 0004           FDB     $0004
04330           0433 FDFC           FDB     $FDFC
04340           0435 FDFC           FDB     $FDFC
```

```
                                TT FOR 7420, ETC.
04360 0437 TT05 EQU  *
04370 0437 01   FCB  1
04380 0438 01   FCB  1
04390 0439 0018 FDB  24
04400 043B 2524 FDB  $2524
04410 043D 2524 FDB  $2524
04420 043F FDFC FDB  $FDFC
04430 0441 F8FC FDB  $F8FC
04440 0443 A5A4 FDB  $A5A4
04450 0445 A5A4 FDB  $A5A4
04460 0447 6564 FDB  $6564
04470 0449 6564 FDB  $6564
04480 044B 3534 FDB  $3534
04490 044D 3534 FDB  $3534
04500 044F 2D2C FDB  $2D2C
04510 0451 2D2C FDB  $2D2C

                                TT FOR 7474, ETC.
04530 0453 TT06 EQU  *
04540 0453 02   FCB  2
04550 0454 01   FCB  1
04560 0455 001E FDB  30
04570 0457 1DC4 FDB  $1DC4      DEFINE - CLEAR
04580 0459 0000 FDB  $0000      EDGE MASK
04590 045B 1544 FDB  $1544      COMPARE
04600 045D 8D8C FDB  $8D8C      - PRESET
04610 045F 0000 FDB  $0000
04620 0461 888C FDB  $888C
04630 0463 1DC4 FDB  $1DC4      - CLEAR
04640 0465 0000 FDB  $0000
04650 0467 1544 FDB  $1544      - TRIGGER ON
04660 0469 DDDC FDB  $DDDC
04670 046B 2020 FDB  $2020
04680 046D F8FC FDB  $F8FC      - TRIGGER OFF
04690 046F 5DCC FDB  $5DCC
04700 0471 2020 FDB  $2020
04710 0473 B56C FDB  $B56C

                                TT FOR 74S138, ETC.
04730 0475 TT07 EQU  *
04740 0475 01   FCB  1
04750 0476 02   FCB  2
04760 0477 002C FDB  44
04770 0479 02FF FDB  $02FF
04780 047B 02FF FDB  $02FF
04790 047D 16FF FDB  $16FF
04800 047F 16FF FDB  $16FF
04810 0481 0EFF FDB  $0EFF
04820 0483 0EFF FDB  $0EFF
04830 0485 06FF FDB  $06FF
04840 0487 06FD FDB  $06FD
04850 0489 86FF FDB  $86FF
04860 048B E6FB FDB  $86FB
04870 048D 46FF FDB  $46FF
04880 048F 46F7 FDB  $46F7
04890 0491 C6FF FDB  $C6FF
04900 0493 C6EF FDB  $C6EF
04910 0495 26FF FDB  $26FF
04920 0497 26DF FDB  $26DF
04930 0499 A6FF FDB  $A6FF
04940 049B A6BF FDB  $A6BF
04950 049D 66FF FDB  $66FF
04960 049F 667F FDB  $667F
04970 04A1 E6FF FDB  $E6FF
04980 04A3 E4FF FDB  $E4FF

05000                   END
```


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Order a personal computer product by mail and receive it in seven days? . . . completely assemble an S-100 music board in three and a half minutes, or 35 minutes from sealed package to computer music?

Impossible? No, not if the company is Software Technology and the product is their "*Music System.*"

I have always been interested in music and, although my piano teacher of 30 years ago might not agree, I have always wanted to play a musical instrument. Until recently I confined my playing to our family organ —only when the family wasn't at home. Because of my interest I have devoured every computer-music article I could find . . . but never got around to putting together the necessary hardware.

Therefore, I couldn't quite believe or resist the brochure that I received in the mail from Software Technology. (Some kind of cousin to Processor Technology, I think.) They are offering for immediate delivery—now that's a most unusual way of doing business—a complete "Music System": S-100 board kit, cassette tape with music operating system and manual for $24.50. Being a trusting individual, I sent my check in the mail the very same day; I received my "Music System" seven days later.

After recovering from that surprise, I rushed home, tore open the package and set to work. Almost before I started assembly I was finished! . . . three and a half minutes by the clock. This is not too hard to understand if you consider that the S-100 circuit board is one and a half inches wide by six

NEW	Start new file
FILE	Define file size and display
LIST	Display current file
DELETE	Delete line or lines of file
SCORE	Compile file
PLAY	Play file
RETURN	Return to resident operating system

Table 1. Music operating system commands. By specifying an address or line number after a command, specific functions are controlled. Only the first letter of a command must be entered—the rest are optional.

W =	Whole note	: =	Triplet
H =	Half note	$ =	Rest
Q =	Quarter note	K =	Key
I =	Eighth note	N =	Tempo
S =	Sixteenth note	* =	Treble clef
T =	Thirty-second note	@ =	Bass clef
X =	Sixty-fourth note	P =	Part
. =	dotted note	R =	Repeat
M =	Measure	' =	Short articulation
# =	Sharp	" =	Long articulation
& =	Flat	, =	Staccato
% =	Natural	/ =	Remark

1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - A - B - C - D - E - and F are the coding for the notes plus or minus middle C

Table 2. Music system high-level language. You can get an idea of how it is used by comparing the coded portion of Fig. 1 with the music. The placement of the notes on the staff is numbered in hex plus or minus from middle C, which is zero (0). C above middle C would be + 7. See Fig. 1, measure 5.

inches long and holds three resistors and two capacitors.

Now, if you are sitting there looking at your five by ten inch S-100 boards and trying to figure out what I'm talking about, let me explain. This board makes two connections to the S-100 bus. One is ground (Pin 50) and the other is PINTE (Pin 28). That's all! The board is just as long as the S-100 socket, and when inserted makes contact with the two pins mentioned above. Trying to install this in a fully loaded motherboard could be a chore. I might even hard-wire this to my CPU board to free a slot.

A coax cable (not included) connects the music board to *your* amplifier (necessary to increase the very low signal level), and music results. PINTE is the 8080 Interrupt Enable lead, and the processor manipulates it in such a way that square-wave tones are generated.

The manual (40 information-packed pages) was obviously written by someone knowledgeable about both computers and music and how to combine the two. Everything is presented in a clear, straightforward manner. In a very short time I had coded and was playing 28 measures of "Born Free" in three voices.

The cassette tape has the music operating system in CUTS format on one side and 300 baud Kansas City format on the other. After loading the tape (4K starting at 0000H is required; 8K or more is recommended) and executing 0000, the command processor is ready for your instructions, most of which are self-explanatory (see Table 1).

FILE defines the amount of memory used, and the starting and ending addresses of the current music file are displayed. SCORE takes the coding that you have entered and compiles it as binary code for the actual playing of the music and displays where this code is located. LIST displays the current file for additions or corrections; PLAY does just what it says it does.

Coding a piece of music for the "Music System" turns out to be much easier than it first appears. Table 2 is a list of some of the symbols used. Once the symbols for the values of different notes have been memorized, it is very simple to move across the page coding one voice at a time. The system can handle three voices (notes) at once and 32 notes per voice per measure. Fig. 1 is an example of a few measures that have been coded.

Lines 0010 and 0030 are remarks; line 0040 defines the key and tempo. The tempo can be changed by increasing or decreasing the figures after the equal sign. The tempo can also be controlled by the computer sense switches (Inport FF) to give you dynamic control of a piece while it is playing. This is just one more reason for me to extend my sense switches to a point outside of my SOL for better accessibility.

The cassette contains six coded classical pieces, so you can hear what computer music sounds like before you try your hand at coding. Load the operating system, load one of the six selections and PLAY for a pleasant surprise.

I believe that I have found one error in the manual. The coding example shown gives the key and tempo as:

```
0060  K2&
0070  NQ-50
```

My system prints error messages unless I place both key and tempo on the same line as shown in Fig. 1c (line 0040). The selections recorded on the cassette tape also use one line for both.

The "Music System" was written specifically for the SOL and the I/O routines that it contains on PROM. Six pages are devoted to helping non-SOL users write the patches necessary to read the CUTS format tape and to access their own screen print routines.

Many other features are provided in the system, and though I don't understand all of the music terminology used, I am sure it won't be long before I am using every available function.

Here is a quick, simple and inexpensive way to get into computer music and impress your friends and family as well. The results are outstanding, educational and, above all, just plain fun! For music with a difference PLAY a little uncoded memory—your monitor PROM, for example. Now there *is* music out of this world! ■

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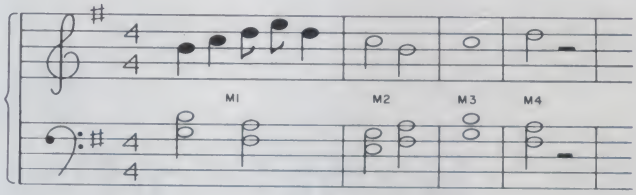


Fig. 1a.

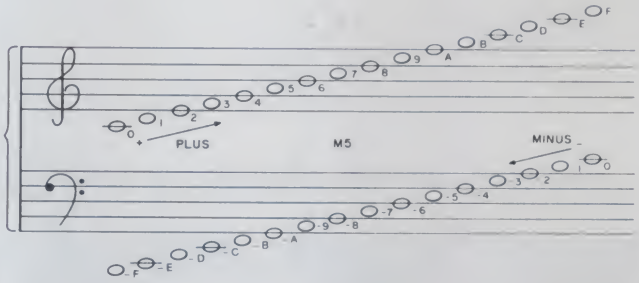


Fig. 1b.

```
0010 / NO SONG
0020 / BY ROD HALLEN 12-21-77
0030 /
0040 K1# NQ=50
0050 PA
0060 M1 V1*Q6Q7I8I9Q.8 V2@H1H2 V3@H3H4
0070 M2 V1*H7H6 V2@H3H2 V3@H5H4
0080 M3 *W7 V2@W1 V3@W3
0090 M4 *H8H$ V2@H2H$ V3@H4H$
0100 PB RA
0110 PC
```

Fig. 1c.

Fig. 1. The music and the coding. Lines beginning with / are remarks and are stored and displayed but not compiled. Line 0040 indicates the key of F# and says make a Quarter note equal to 50 iterations of a loop in the tone generator. More or less determines the tempo. 0050 defines the beginning of part A. 0060 is measure 1. It reads—Voice 1 (V1)—Treble Clef (*)—Quarter note 6 (Q6)—Quarter note 7 (Q7)—Eighth note 8 (I8)—Eighth note 9 (I9)— dotted Quarter note 8 (Q.8). V2, V3 and 0070 to 0090 read the same way. 0100 indicates that part B will be a repeat of part A. 0110 will be the beginning of part C. Once coding is learned, many of the symbols that are shown can be left out since note value once set will remain the same until reset. As an example: Q6Q7I8I9Q.8 could be written Q67I89Q.8.

Build a Serial-to-Parallel Converter

Connecting parallel devices to serial ports is a snap. If you doubt it, read this article.



Serial-to-parallel converter in enclosure. Unit will accept either serial TTL or RS-232 inputs while also providing similar outputs to be used elsewhere. Parallel TTL outputs are available through a ribbon cable at the rear of the enclosure, shown here with a DB-25 connector.

F. R. Ruckdeschel
773 John Glen Blvd.
Webster NY 14580

After two years of soldering, I am embarrassed to confess that my software files can all be stored on three C-60 cassettes (300 baud). Although sufficient hardware has been in place for more than a year to do general programming, the satisfaction of making shiny solder connections has become an obsession; 22-slot Imsai motherboards are particularly inviting with their 2200 connections. The therapeutic value of relaxing over a hot soldering pencil must be similar to the satisfaction derived from knitting. However, a point is eventually reached at which the guilt of not using the computer (an Imsai) for its intended purpose becomes overwhelming.

I reached this point recently and made a resolution to concentrate on software. I sat down at my dual CRT terminal and began to dream about creating some money-making software, or at least a game. It was about time the graphics display was used for something other than checking whether or not it worked. As I started to type in a little program, the line overwriting of the terminal became intolerable. Thus, the terminal was disassembled, and the line-feed signal was jumpered to the line erase on the cursor board.

Now I was ready to go again. After a few hours, it became apparent that the paper-saving CRT display was helpful in forest conservation, but was also confusing when trying to remember where to jump to in a program (or where one jumped from). Obviously, hard-copy output was needed.

Coincidentally, I had previously constructed a PR-40 printer (actually, only the interface). However, the printer interface required seven-bit parallel input plus a strobe. All I had immediately available was the parallel port used with the graphics display. My first thought was to design and build or buy — in kit form, of course — another parallel I/O for the Imsai. However, remembering my resolution, I decided to build a small serial-to-parallel converter that would simply tap into the RS-232 line coming from (or going to) the terminal. Obviously, an etched PC board was required to assure the esthetics of soldering. This was the origin of the schematics and foil pattern shown in this article.

Operating Features

Before I could charge ahead, a few of the operating features needed to be established:

1. The parts used had to be on hand. I used a 7400 quad NAND gate as an inverter. The clock required for the universal asynchronous re-

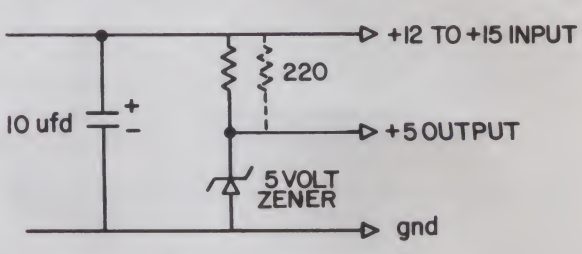


Fig. 1. Five volt power supply.

ceiver-transmitter (UART) was to be based on a 555 timer. I did not have the UART itself, but chose the AY-5-1013 for its price (about $6) and particular ability to be used for five-bit reception. Someday, copying Baudot might be desired.

2. The interface was not to create any software overhead. After all, in spite of the resolution, I had always avoided software; so why change? Thus, the interface was required to create a data strobe to go with the parallel output.

3. The unit had to be flexible in baud rate and data format, mandating the use of trimpots and switches.

4. The parallel output line was to have LEDs to display the actual data format. This is useful in deciphering a terminal's parity and data bit number. This feature has been useful in determing Mits computer terminal formats since, for some reason, that information is missing from my manuals.

5. Flexibility was to be maintained to cope with unforeseen situations, such as negative logic signals.

The schematics shown in Figs. 1 through 4 accomplish most of the above goals at a low cost. The circuitry is fairly simple and has worked reliably for several months.

Circuit Description

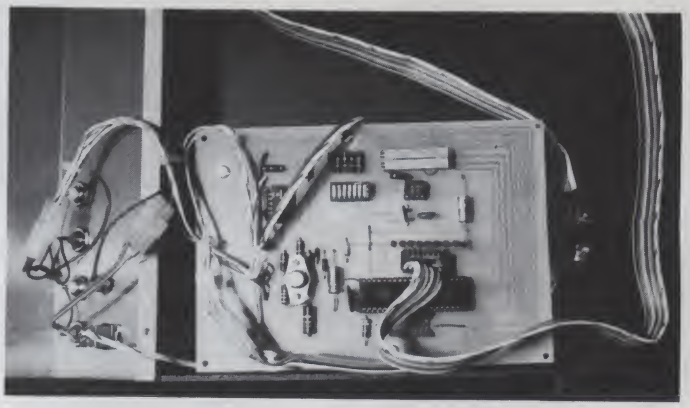
Power supplies: The AY-5-1013 UART requires supply voltages of +5 and -12 volts, nominally ±5 percent. As I have previously needed a buffered RS-232C signal, one additional supply requirement of +12 volts was added. Those voltages can all be derived from a ±15 volt op amp supply; 250 mA capacity is more than sufficient.

As the load current requirements are fairly low, simple zener regulation was used. The filter capacitor is on the source voltage line to keep ripple away from the regulation voltage level.

The 5 volt supply shows two parallel 220 Ohm current-limiting resistors. One is sufficient if the optional data output LEDs are not used. If the source voltage is not 15 volts, some experimentation will be required to determine the proper current-limiting resistor.

Resistor values shown were chosen by putting the entire unit in operation (all LEDs on) and adjusting the net resistor value (starting high) until 30 mA of the load current was passing through the zener. This appears to give a sufficient regulation margin and does not lead to excessive power dissipation in the 5 volt zener.

Clock: The circuit shown in Fig. 3 provides a TTL square wave output whose frequency is dependent on the values of R and C. A choice of two frequencies is available through switched trimpots R_1 and R_2. For my purposes, the two frequencies of interest were 300 and 600 baud, and the corresponding component values are C=.003 uF with 10k Ohm and 500 Ohm trimpots. The clock is best set using a digital counter and setting the frequency to 16 times the desired baud rate. A second choice is an oscilloscope comparison with the 60 Hz line frequency. A third choice is trial and error, which is not difficult if the data LED indicators are used. Although I was apprehensive about clock stability, this has never been a problem.



Enclosure disassembled. Front-panel connections are shown at the left. Main board contains a DIP socket for the parallel output ribbon cable. Immediately below the DIP socket is the UART. Immediately above are the eight optional LED indicators that show the status of the parallel output lines. In the upper middle area of the circuit board is a DIP switch for choosing parity, number of stop bits, etc. Directly to the right of this switch is the 555 clock generator, above which are the two trimpots for frequency (baud rate) control. The power supply is out of view beneath this board.

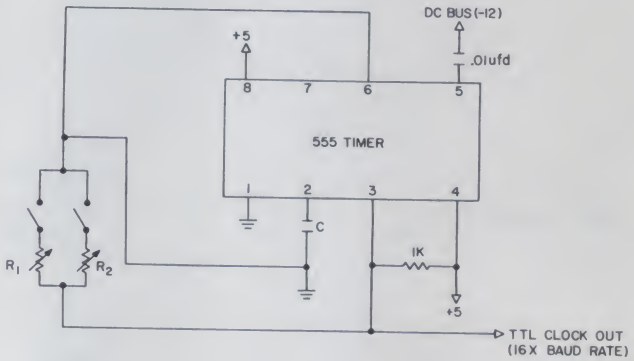


Fig. 3. Clock source for determining the bit rate (baud).

Serial-to-parallel converter section: The AY-5-1013 is fairly easy to use. The TTL serial input is obtained from the emitter follower transistor arrangement shown in Fig. 4. This transistor is biased so that with no input (open input line), the emitter resides at approximately 0 volts. If a transistor other than a 2N2923 is used, some adjustment of the bias resistors may be required. The emitter generally follows the input signal, though the negative swing is more limited than that in the positive direction. This asymmetry causes no trouble at all with the eventual TTL level and causes little difficulty with the buffered output.

The buffered RS-232C signal is converted to TTL levels by a 5 volt zener diode. The small (≈ .6 volt) negative swing of the signal at the zener side of J5 is acceptable to the circuitry that follows.

The J5 jumper position is a key signal node. With a RS-232C signal input, the TTL signal may be fed directly to the UART input or may be inverted. Normal RS-232C signals use negative voltage swings to represent 1 and positive swings to represent 0. Thus, inversion is required. This is accomplished through the jumper between J5 (right) and J6, which inserts an inverter in the signal path. The zener side of J5 also offers an entry point for TTL serial input

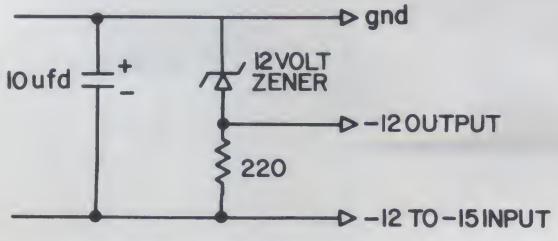


Fig. 2. Negative twelve volt power supply.

signals. Again, the inversion option is available.

What the UART does with the input is determined by the 5 control bits (EPS, NB1, NB2, TSB and NP). These bits are selected by the 5 DIP switches at the lower right of the schematic; a pull-down arrangement is used, the control bits are always enabled as the control strobe (CS) input is hard-wired to a logic 1 level.

Other control signals permanently enabled are $\overline{SWE}$ and $\overline{RDE}$. These cause the status word bits and received data bits to be continually and immediately placed on their respective output lines. In the case of the parallel output lines, LEDs containing internal resistors are used to indicate the output logic levels.

A strobe (active low) signal is automatically created upon reception of a serial input character. Such a strobe is required by the PR-40 interface. It can also be conveniently used to enable Tri-state buffers leading to a data bus, etc. This strobe is generated by the two inverters appearing at the lower left of Fig. 4. The data available (DAV) signal from the UART is used as the initiator for this signal. The DAV flip-flop signal is inverted by the 7400, the output of which is the active low signal desired.

However, unless the DAV flip-flop is reset, this signal does not return high to do the same for the next character received. Thus, the signal is again inverted and, after an RC delay, applied to the external reset (XR) control on the UART. This resets *all* the UART flags, including DAV. The reason for using XR and not DAV reset (DAVR) is to ensure that at some later date the error flags (OR, FE and PE) may be

Item	Quantity	Description
Integrated circuits	1	AY-5-1013 UART (General Instrument part; obtained through James Electronics).
	1	555 timer.
	1	7400 quad NAND gate.
LEDs	8	Internal resistor LEDs (Polypaks: order extras as the yield rate I observed was 6/8).
	1	LED (almost any low-current device will do).
Zeners	1	12 volt.
	2	5 volt.
Transistors	1	NPN with reasonable breakdown characteristics; 2N2923.
Capacitors	2	10 uF tantalum, 25 volt.
	1	.003 disk (depending on baud rate).
	1	.01 disk.
	1	.1 disk.
Resistors	3	220 Ohm, 1 Watt.
	1	330 Ohm, ½ Watt.
	6	1k Ohm, ½ Watt.
	1	3k Ohm, ½ Watt.
	2	4.7k Ohm, ½ Watt.
	1	10k Ohm, ½ Watt.
	1	33k Ohm, ½ Watt.
	2	Trimpots (depending on baud rate).
Switch	1	16-pin DIP switch.
Power supply	1	±15 volts @ 250 mA worked well.
PC board		Single-sided, etched but undrilled board is available from the author for $7.50. New York State residents, add sales tax.

Table 1. Parts list.

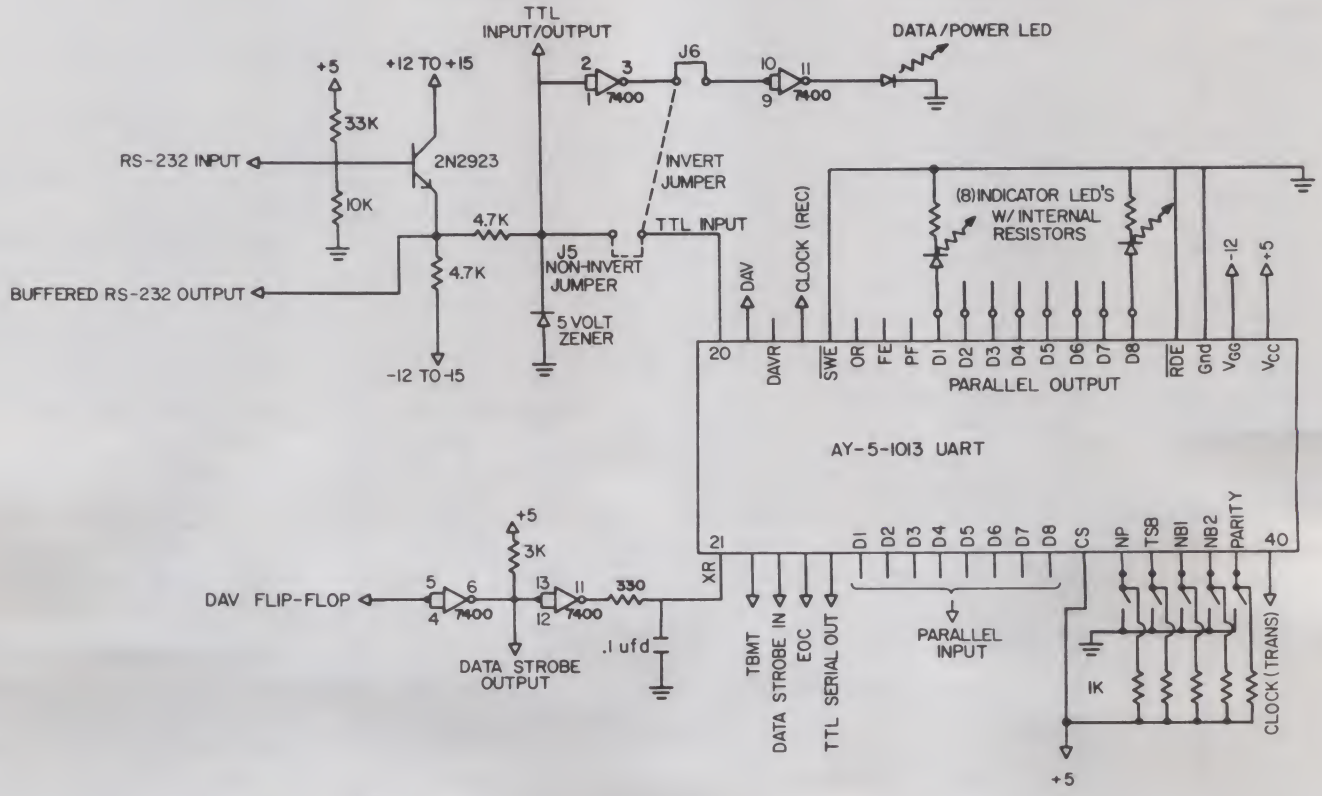


Fig. 4. Conversion section of serial-to-parallel converter.

conveniently monitored. With the components shown in Fig. 4, the strobe pulse length is seven microseconds. (For those who have attempted to interface their PR-40s directly to a Mits parallel I/O, there is a small problem: The output strobe duration is too short. A pulse stretcher [greater than one microsecond] is required.) The parallel output signals, along with the strobe, are all that are required to drive the PR-40.

Other circuitry: To indicate both the presence of power, signal and signal polarity error, the simple data/power LED circuit was added. If the converter is turned on but not connected to a serial input line, J6 goes to a logic 1 state and the LED is enabled. If the signal line is connected but there is no data transmission, a mark signal is received. If this mark leads to a TTL 1 level, the LED stays on. If the signal line polarity is wrong, the LED goes out, indicating a fault; changing the jumper corrects this. If the power is on and the signal line polarity correct, then a data signal is apparent by flicker in the LED.

Also included on the printed circuit foil pattern are provisions for parallel-to-serial conversion using the existing clock. The required parallel input and strobe signals may be obtained directly from a typical Mits parallel I/O board. Note,

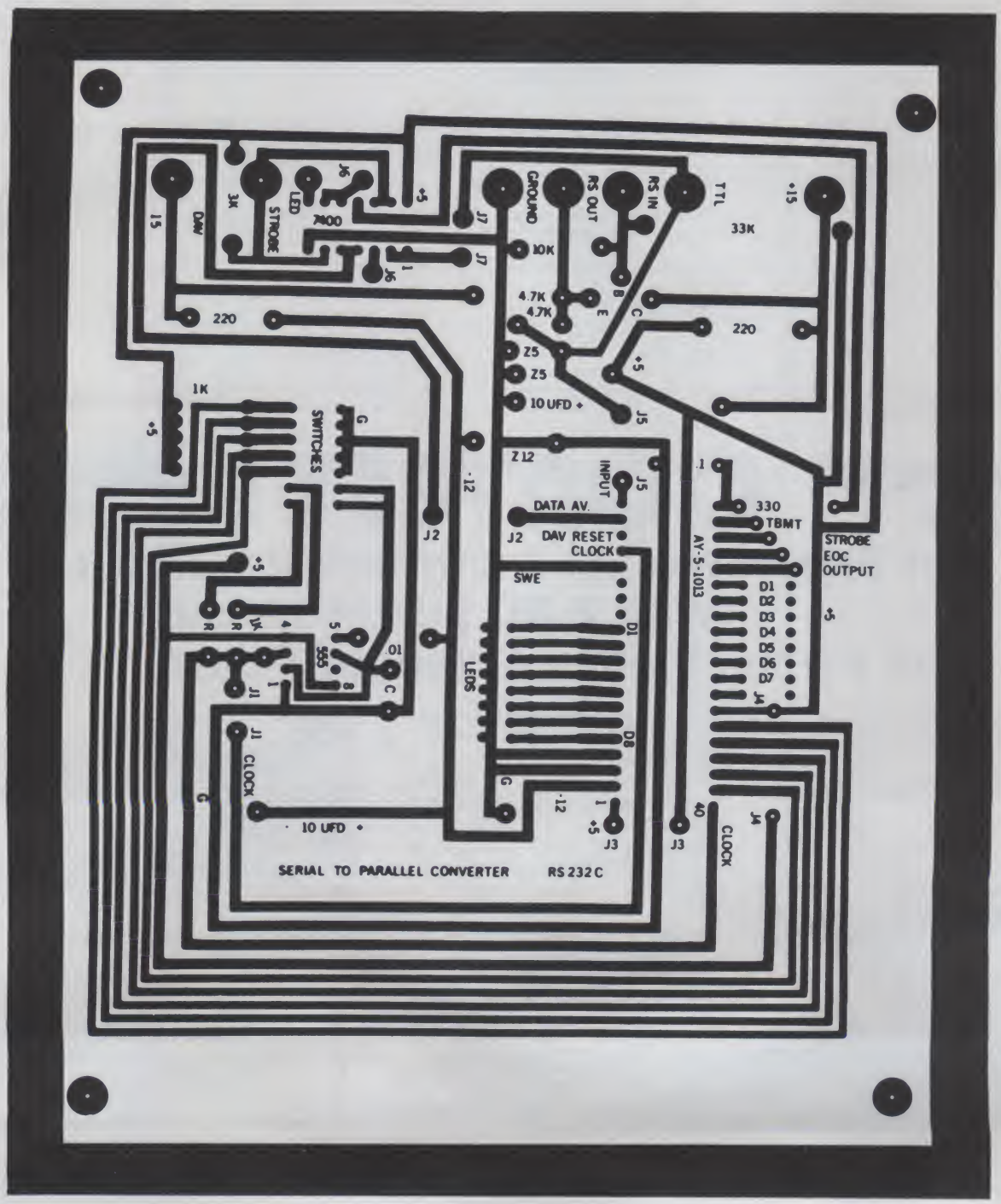


Fig. 5. Printed circuit foil pattern.

however, the serial output signal is TTL level and not RS-232C. A simple transistor circuit could easily be designed to translate the logic levels.

It should also be noted that the flags associated with parallel-to-serial conversion can be reset by a serial character input, as XR is activated upon reception.

Converter Operation

The operation of the serial-to-parallel converter is straightforward. Simply connect the input and output lines. However, there is one operating characteristic of the PR-40 mechanics that must be accounted for: slow print head return. If the converter is hooked to the terminal transmit line, there is no problem; a one-second wait after a carriage return is sufficient. If instead the converter is connected to the terminal receive line, it is possible that data may be received during a print cycle. This may mess up the printed line or data may be lost. Such a situation may be avoided by use of a software delay (at last, software). Most of the larger BASICS have a null command, which can be used for such a delay.

Although the setup is fairly foolproof, I have managed to accidentally create a curious fault. It is possible to set the serial transmission format (parity, stop bits and number of data bits) variously different on the computer SI/O board, terminal and converter so the terminal receives and transmits without display error; but the converter, when placed on the terminal receive line, gives the printer "correct" data only upon terminal echo, and not with computer-generated text. Thus, a little consistency in format is necessary.

Epilog

Once the printer was on line through the serial/parallel converter, the beauty of CRT displays became evident. It is easy to create yards of printout, again making it difficult to determine what was done and, more important, keep a concise log. My response was to connect the converter to the terminal's transmit line. In this way, all the statements typed are recorded, and not the returning prompts, syntax errors, etc. Also, the printer is in a local mode and can be used to record what was previously handwritten in my notebook — whether or not the computer is on (or working).

Now to concentrate on software. ■

A kit for building this project is available from: O.C. Stafford Electronic Service and Development Co., 427 S. Benbow Rd., Greensboro NC 27401.

PC board: $7.50, drilled; $5.80, undrilled (part no. KB 2-78)
Negative or positive: $3
Parts kit (no board, no PROM), $27
PROMs: 1024 × 8, $39.50; 512 × 8, $15

Add $1 for shipping

CONTEST!

1st Prize: Mullen Controller Board Kit with 2 AC power modules

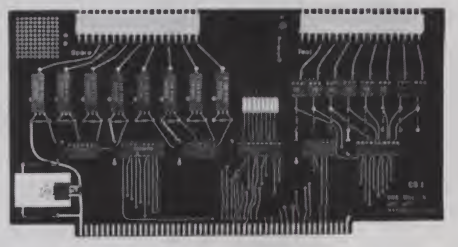
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(Pictured: S-100 buss compatible Controller Board. Heath H8 version also available.)

Contest Rules: For further information on Mullen Computer Products, visit your local computer store or write us. All entries must be postmarked no later than midnight, Dec. 15, 1978, and become property of Mullen Computer Products. Enter as often as you wish. Duplicate prizes awarded in case of tie. Please print your name clearly on the entry. Try to keep descriptions short, but if you get carried away describing some fantastic scheme we'll understand. Good luck, and we look forward to hearing from you.

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The PET, unquestionably, has become the standard for the personal computer industry. As such, consumer and business publications have lauded its discovery. It comes out of the box, plugs into the wall, and is ready to use.

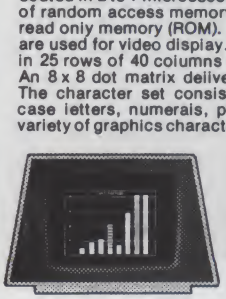
IN A LEAGUE WITH IBM, HP AND WANG MINICOMPUTERS

The fully integrated PET is a minicomputer and should not be confused with game products that hook up to household T.V.'s. **What sets it apart from other computers is price. While others cost from $11,000 to $20,000 and more, THE PET, with similar power, is only $795.00.**

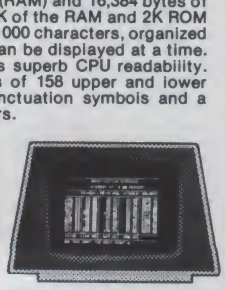
It is of sufficient size and speed to accomplish many of the routine computational tasks facing engineers and scientists. By combining an extended BASIC interpreter with one of the fastest microprocessors available, Commodore has created an incredibly capable, yet inexpensive, computer.

POWERFUL 6502 HARDWARE:

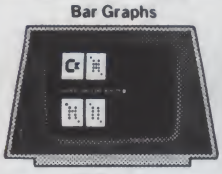
The mind-boggling PET has all necessary functional elements packaged in a single cabinet. Its CPU is a MOS Technology 6502 8 bit microprocessor which can address 65,536 bytes of memory directly. It has 56 instructions and 13 different addressing modes. Depending upon address mode, instructions are executed in 2 to 7 microseconds. The unit has 9216 bytes of random access memory (RAM) and 16,384 bytes of read only memory (ROM). 1K of the RAM and 2K ROM are used for video display. 1000 characters, organized in 25 rows of 40 columns can be displayed at a time. An 8 x 8 dot matrix delivers superb CPU readability. The character set consists of 158 upper and lower case letters, numerals, punctuation symbols and a variety of graphics characters.



Bar Graphs



Amortization Chart



Black Jack



Teaching Trigonometry

All characters can be displayed in normal mode -white on black, or reverse - black on white. Since the display is part of main memory, it can be accessed directly by the CPU. Flexibility is enhanced by the full screen editor. Input is either from the 10-key numeric keyboard, with its full cursor control, or the built-in cassette tape drive. All symbols used in BASIC statements are available in the unshifted mode for added operating speed. The cassette can be used to read and write programs and data at 50 bytes per second. A second cassette port, 8 bit parallel I/O port and IEEE-488 bus port are also provided. The entire system weighs 38 lbs. and measures approximately 15½" high x 17¼" wide x 18½" deep.

The PET is completely silent in its operation. No special installation is necessary because it operates on ordinary 110V household current at 50-60 Hz.

INCREDIBLE FIRMWARE FLEXIBILITY

The firmware's three primary components include the operating system, full screen editor, and BASIC interpreter. Together these programs use 14 K bytes of read only memory.

DIRECT ACCESSORY PLUG-IN

The unit's operating system permits you to easily load and save programs. One of its exclusive features is complete support for the **IEEE-488 instrument bus**, which is occasionally referred to as an HP-IB bus. This bus provides superb flexibility. Through it, you can connect up to 12 devices to the PET, at the same time. This universal port permits direct connection of the PET Printer, in addition to a wide variety of measurement and control instruments such as counters, timers, spectrum analyzers, digital voltmeters and printer plotters, from HP, Phillips, Fluke and Textronix. Many academic, industrial and governmental labs are already using PETS as laboratory automation control computers.

With the PET's full screen editor, an entire program, a selected section, or a statement can be listed. The cursor can be moved as needed on the screen, and characters can be changed, inserted or deleted to modify any program statement. Statements can be copied or moved by changing their line number. New statements can be added, or old deleted, as desired.

COMPLETE COMPUTER PERFORMANCE

The BASIC interpreter enables a superset of the original BASIC. Among its major features are floating point, integer and string arrays of limited dimensionality, dynamic string handling, 5 byte floating point number representation (for approximately 8 decimal digit accuracy), PEEK and POKE commands for direct memory access, two character variable names, full support for IEEE-488 bus devices, program chaining with full data retention between overlays, built-in mathematical (ABS, ATN, COS, EXP, INT, LOG, RND, SGN, SIN, SQR, TAN) and string (ASC, CHR, LEFT, LEN, MID, RIGHT, STR, VAL) functions; user-definable functions; multi-statement lines; real-time clock; support for machine language subroutines; both character and line input capability.

HIGH SPEED PET PRINTER

This powerful word processor prints hardcopies, invoices, computer correspondence. Faster than an IBM Selectric, The PET Printer delivers 60 characters per second at a sustained rate -- with upper and lower case capability. Characters are one-eighth inch tall and are printed in a large 8 x 7 dot matrix. The printer uses a standard 8½" wide paper roll. And, it is only $695.00.

PERIPHERAL SECOND CASSETTE

This optional component expands storage, increases flexibility, and is just $99.95.

SOFTWARE

Application programs for the PET can of course be written by the user, and most special purpose programs will be so written. A growing library of programs is already available.

PROGRAMS AT $29.95 EACH:

☐ **Basic Math Package:**
Matrix operations-entry, editing, addition, subtraction, multiplication, inversion, determinants, solution of simultaneous equations.
Vector operations-entry, editing, addition, subtraction, dot and cross products, length, angle between vectors.
Plane and spherical trigonometry-calculate sides and angles of triangles, areas of regular polygons.
Numerical integration and differentiation-interactive entry, editing and display of data; Simpson's rule, trapezoidal method and Gaussian quadrature integration algorithms; differentiation allows arbitrary interval size.

☐ **Basic Statistics Package:**
General statistics-calculates mean, median, standard deviation, skewness, kurtosis, frequencies, range, and variance of a data set.
T-tests-to determine the significance of a difference between the means of independent groups, matched groups, mean gains of paired groups, known and observed means and means of sample proportions.
Chi-square test for independence between two statistical processes.
Correlation and regression-calculates Pearson product moment correlation coefficient and the regression line.

PROGRAMS AT $24.95 EACH:

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Loans, annuities, return on regular and irregular sequences of payments, calendar calculations.
☐ **Stock Portfolio Recordkeeping and Analysis:**
Keeps track of buys, sells, and dividends. Calculates current value, rates of return.
☐ **Checkbook Recordkeeping and Analysis:**
Keeps track of checks and deposits. Analyzes expenses by date and type.

PROGRAMS AT $14.95 EACH:

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☐ **Diet Planner and Biorhythm**
☐ **Basic Basic-***by Lodewyck and James*

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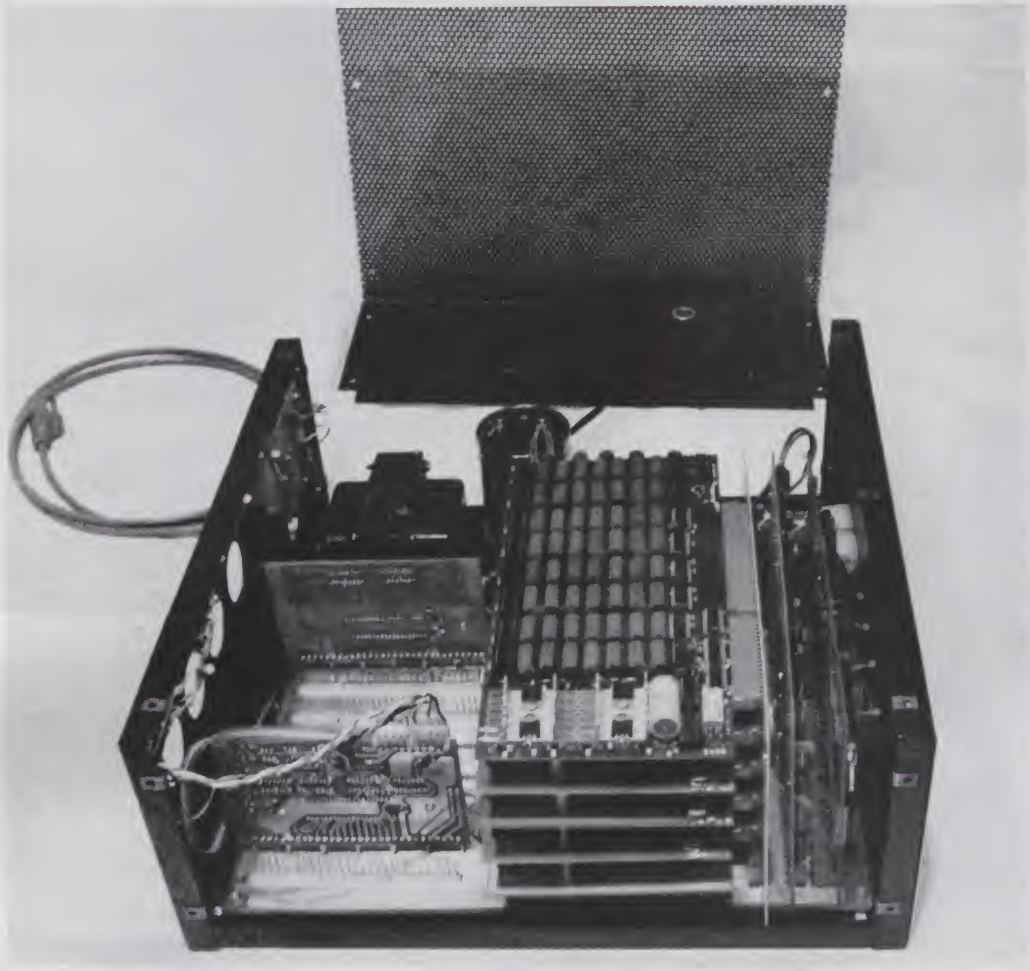
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Expansion Time!
S-100 Memory for SWTP System

With ingenuity, you can use S-100 memory boards in your SWTP machine . . . a dollar-saver.

Stuart Mitchell
14761 Dodson Dr.
Woodbridge VA 22193

Phil Poole
1408 Idaho
Woodbridge VA 22191



Completed assembly with 28K of memory installed. Note fan mounted on cover for cooling memory.

Money and memory are two things you can never have enough of for your microcomputer. Although the SWTP 6800 computer with 4K memory sounds like a great deal (other processors come with even less or no memory at all), you will soon discover that 4K isn't enough to be useful. Prompted by several friends, we came up with additional memory for the 6800. You'll find this solution is similar to our Mits 680b memory expansion ("Make Your 680b Smarter," *Kilobaud* No. 3, p. 102), except that it's less expensive . . . nothing needs to be done about the power-supply requirements. We hope this article will alleviate your money and memory shortage, at least temporarily.

Theory

There is nothing magical about saving money—the more of something you produce, the lower the cost and selling price. The so-called S-100 memory is a good example. Ithaca (NY) Audio's bare memory board (which sells for $25) and a little judicious parts ordering will net you 8K of 450 ns static memory for about $120. Although it sounds easy—order the parts, assemble according to the instructions and plug it into your SWTP 6800, and presto, 12K of memory just like that—there is a catch. It won't plug in because the sockets don't match. Correcting this situation is what the rest of this article is about.

The 6800 will take 32K of memory (remember, 4K came with your computer). Many S-100 static memory boards, like S.D. Sales 4K and Ithaca Audio 8K, are available. We have laid out a PC extender that will take up to five boards. To experiment, we used four S.D. Sales 4K boards, temporarily borrowed from other computers, and a new 8K board from Ithaca Audio. All went well.

The only interconnections that aren't straightforward are the connections of the S-100 *Data In* and *Data Out* buses to the bidirectional bus in the 6800. If memory boards like the 8K Ithaca Audio or the 4K S.D. Sales are used, simply tie the corresponding data lines together; the R/W line will select the appropriate Tri-state buffer. As usual, the R/W line must be inverted, and the protect features not enabled.

Construction

Collect the parts and pieces for the memory boards. We suggest you buy the maximum number of ICs on your first purchase since the 21L02s are cheaper by the hundreds (call Ithaca Audio for current prices). Share the expense with several other people to save a few extra dollars on the memories.

Etch the extender card using single-sided copper-clad board using the photo layout in Fig. 1. If you use the Calectro Kit for making printed circuit boards directly from this magazine, check to insure that there are no holes in the solid black areas; if there are, use india ink to fill them in before processing. Sockets for the S-100 are standard .125-inch pin spacing and .250-inch row spacing.

As usual, we have chosen to use the spliced-socket method, which reduces the cost since odd-length sockets are available at most surplus houses. Add two socket pins together to give you more than 100 (50 each side); this is required. We found that using a hacksaw is the easiest way to cut them; but leave two extra pins on each socket. Grind or file each socket down to the final dimension.

Using this method reduces the total cost for the S-100 sockets from $20 to about $5. The SWTP sockets for the edge of the extender card can be obtained from SWTP ($3/set), or see your local General Electric TV repairman and get them off the bad TV plug-in modules (boy, are we cheap!).

Mount all sockets on the printed circuit card and solder them in place. It is OK if you don't mount all the S-100 sockets, but use the bottom slot because the pins make a good point to connect the jumpers to the SWTP bus. Use the interconnect chart to determine which pins go together.

There is one 5 volt regulator (7805) and a filter capacitor to be mounted on the 6800 extender card. It is used for IC1, which is a 7404. This inverter is used to invert the signal from pin 47 and send it to pin 68 of the S-100 bus. S-100 pins 45/46 must be grounded for the Ithaca Audio 8K board to be addressed properly. Well, that's it for the 6800 extender board.

We strongly recommend that if you use very many memory cards, you install a muffin or whisper fan for cooling the new memory cards. As you can see in the photos, the fan mounts on the cover with four small bolts; no modification is needed to the SWTP cover. Wire the fan in parallel with the primary of the power transformer. These fans are available from several mail-order houses for about $5-$7. *Be sure to unplug your computer when wiring in the fan*!

To test the extender card, plug it in the third slot from the front of the computer with no memory cards installed. Now install the CPU card in slot one (closest to the front panel); the original 4K memory is installed

6800 Designation	6800 Pin #	Buffer In Pin #	Buffer Out Pin #	S-100 Pin #	S-100 Designation
D0	1	-	-	95	DI0
D0	1	-	-	36	DO0
D1	2	-	-	94	DI1
D1	2	-	-	35	DO1
D2	3	-	-	41	DI2
D2	3	-	-	88	DO2
D3	4	-	-	42	DI3
D3	4	-	-	89	DO3
D4	5	-	-	91	DI4
D4	5	-	-	38	DO4
D5	6	-	-	92	DI5
D5	6	-	-	39	DO5
D6	7	-	-	93	DI6
D6	7	-	-	40	DO6
D7	8	-	-	43	DI7
D7	8	-	-	90	DO7
A15	9	-	-	32	A15
A14	10	-	-	86	A14
A13	11	-	-	85	A13
A12	12	-	-	33	A12
A11	13	-	-	87	A11
A10	14	-	-	37	A10
A9	15	-	-	34	A9
A8	16	-	-	84	A8
A7	17	-	-	83	A7
A6	18	-	-	82	A6
A5	19	-	-	29	A5
A4	20	-	-	30	A4
A3	21	-	-	31	A3
A2	22	-	-	81	A2
A1	23	-	-	80	A1
A0	24	-	-	79	A0
R/W	41	-	-	47	SMEMR
R/W	41	IC1,1	IC1,2	68	MWRITE

Table 1.

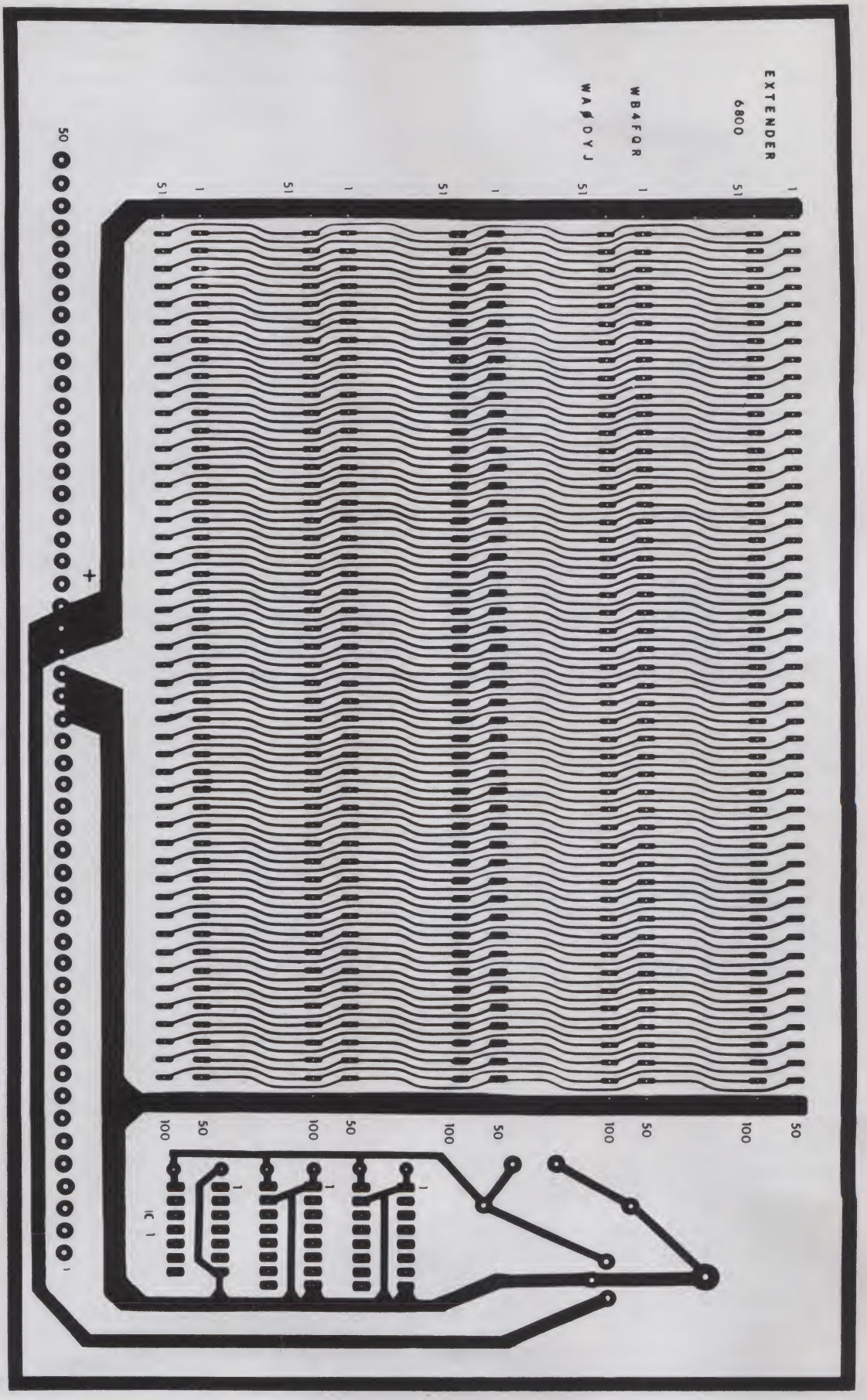


Fig. 1.

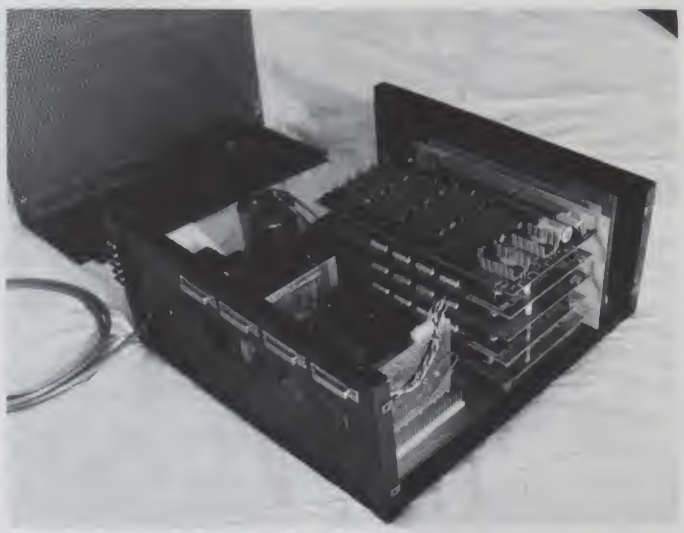
in slot 2, and the I/O cards remain unchanged in the back. Turn the computer on and check supply voltages. The 7404 (IC1) should have five volts between pin 14 and 7. Check S-100 pins 47 and 68; they should be inverted from each other.

If all is OK, power down the computer, insert one memory card, power up, and you should be ready to run your favorite memory-check program. Don't forget where you addressed the additional memory card. If the memory check didn't work, check the switches or jumpers on the newly installed memory to make sure they are properly addressed.

Conclusions

The extender card is easily built, inexpensive and operable. Several are in use already. As one fellow said, "It's so simple I should have done it last year." Up to 32K of memory is possible, so five slots are enough if 8K memory boards are used. The main disadvantage is that the S-100 memory cards use up the SWTP bus slots. There may be other physical configurations; we would like to hear your ideas.

For other experimenters, a full-size positive or negative PC layout is available for $7.50. An etched, plated and undrilled printed circuit card is available for $15 from the authors.■



White spacers visible on right edge maintain vertical spacing of the memory cards.

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What Is a Bus?

A computer's bus is a lot more than something to plug boards into . . . especially if you're designing or troubleshooting it.

Every modern computer uses buses for the interconnection of its parts. This circuit structure is familiar to computer hobbyists, but for persons with experience in other fields of electronics, the function and peculiarities of buses can be confusing; for the novice in the field of electronics, buses can be outright puzzling. In this article I will attempt to give a systematic description of the various types of buses that can be encountered in a computer.

A Bus is a Bus by Any Other Name . . .

Bus is an abbreviation of omnibus. Few people who board a bus for a trip to the airport or across town would give a second thought to the roots of this word. Like many words of daily use, it has its origin in Latin. Omnibus (my old Latin teacher would be proud of me) is the dative plural form of the word *omnis* meaning *all*. Omnibus, therefore, means *for all* or, loosely translated, *for everybody*.

At a time when people traveled in private horse-drawn coaches, a vehicle for the convenience of everybody was called an omnibus and the name has stuck not only for vehicles, but also, generally, for any commodity for the benefit of more than one person. That explains the *omnibus bills* that appear—usually just before summer recess—in state and federal legislation and have nothing to do with transportation, but are just vehicles to give senators or congressmen a chance to propose a law of their own.

Power Buses

In electricity, buses have been around long before there was such a thing as electronics. Normally, an electrical connection or a wire goes from one point or terminal to another point or terminal. But frequently, connections interconnect more than two, and sometimes many, points in a circuit. Such a connection may be called a bus, and bus-bars can be found in every electrical distribution panel where they connect the incoming power line to the various circuit breakers.

In a computer (or any other electronics device), a power-distribution bus connects the power supply with the many circuit boards and distributes the power to the individual circuit components. Because these power buses often have to carry relatively large currents, they frequently are hefty wires or, in printed-circuit boards, they are implemented with traces that are wider than the other circuit traces, which carry only information.

Message or Information Buses

In the majority of the buses within a computer system, information, rather than power, is ported over the bus. In this case, one or more devices send out electrical pulses that represent messages that are received by one or more other devices. In one particular standard for bus systems (IEEE 488), these devices are called either talkers or listeners, according to their function. These names convey an excellent idea of what is happening in the process of information transfer and shall be used in the following.

One Talks and Many Listen

The simplest data bus is one that connects one talker to several listeners. The flow of information is obviously unidirectional (namely, from the talker to the listener), and the bus is nothing more than a simple connection from the output of the talker to the inputs of the listeners. Because every listener input presents an electrical load to the bus, the output of the talker frequently has to be a bus driver, a circuit that can provide all the power required by the load in a short time.

Such buses can consist of a line or lines that together are considered a bus. Examples of the single-line buses are the clock-pulse line and the Read/Write line (both of which are usually not called buses in the manuals). In both of these buses, the microprocessor does the talking and every other device in the system just listens.

The best example of a bus consisting of several lines is the address bus, which usually is 16 lines wide. On this bus, too, the microprocessor does all the talking while the other devices listen. (An exception to this situation is the so-called DMA, or direct memory access, where, on occasion, some other device talks on the address bus. Obviously, you have to make sure that the microprocessor does not talk at the same time because utter confusion could result. This can be avoided by temporarily disconnecting the microprocessor from the bus.) These unidirectional buses are the simplest type, but things can still go wrong.

One problem that can occur is bus loading. The devices connected to a bus are designed by their manufacturer to safely read a voltage level as a logical 0 or 1 if it is below or above a certain level. For TTL-type devices these levels are usually about .8 volts and 2 volts.

If too many loads or devices are connected to a bus, the bus driver may be unable to drive the bus voltage to these values (or may take too long to reach this value). Instead of a high voltage of 2 volts, it might just barely make it to 1.9 volts, for example. Most devices connected to the bus are likely to still interpret this voltage as a 1, but their manufacturer does not guarantee that they will. In this case, all kinds of bad things can happen. So, the load on a bus and the bus driver have to be matched in order to make sure that doesn't happen.

Other problems are crosstalk and bus reflections. Both effects result from every bus line's having a capacity with respect to other bus lines and to ground. The capacity-to-adjacent bus lines can cause crosstalk (i.e., a pulse on one bus line is capacitively coupled to some other bus line).

The capacity-to-ground—

together with the inductance that every wire represents—can make a bus act as a kind of resonant tank circuit. The result is bus ringing, which can cause false voltage readings, especially when fast or short pulses are used.

The shielding of bus lines (usually by a groundplane) and the termination of buses by resistors (or clamping diodes) can help reduce this problem. The S-100 bus—because of its many closely spaced bus lines—seems to have been troubled by both problems on occasion; several companies offer S-100 backplanes that utilize groundplane shielding and bus terminations to overcome the problems.

One Ear for Many Talkers

The opposite of the bus just described is one that connects many talkers to one listener. Obviously, if more than one talker talks at the same time, the listener might not be able to understand what is being said, although he knows that somebody is trying to get his attention.

An example of this type of bus is an interrupt line, which allows any one of several devices to signal the microprocessor that it requires service. The solution to this problem apparently is to simply connect the output of several devices to the appropriate input of the microprocessor. If you try to do that, however, you have to observe some of the peculiarities of the devices used for this game.

The output of the normal TTL-integrated circuits has a so-called totem-pole configuration. (With CMOS circuits the situation is similar.) This means there are two transistors at the output, with one sitting on the shoulders of the other one. The effect of this arrangement is shown in Fig. 1. The output of the device appears to be connected through a closed contact (which, of course, is actually a transistor) either to +5 volts or to ground, depending on whether the device tries to pull the output line to a logical high or low.

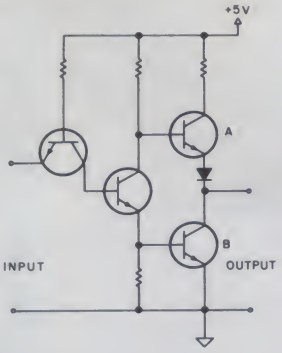


Fig. 1a. Circuit diagram of a TTL gate or inverter with totem-pole output. (Transistor A sits on the shoulders of transistor B like figures on a totem pole, thus, the name.)

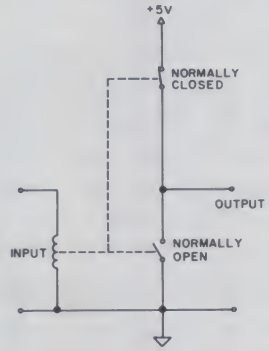


Fig. 1b. Equivalent circuit in which the two output transistors have been replaced with the contacts of a relay.

That works fine until you connect the outputs of two (or more) of these devices together.

Now, if one of the devices tries to pull the output line to +5 volts while the other one tries to pull it to ground, the two closed contacts appear to provide a short circuit between +5 V and ground. In reality, it is not quite that bad, and you are not likely to blow a fuse (maybe not even an IC) when that should happen; but the bus goes neither to +5 V nor to ground, but to some unpredictable level in between.

Circuits with this output configuration, therefore, cannot be connected together; you have to use another group of TTL devices that have a so-called open-collector output. In these devices, transistor A, which is the upper man on the totem pole, has been left off and the output is simply the collector of transistor B. In order for this device to function properly, an external collector resistor has to be provided.

As shown in Fig. 2, the collector resistor can be connected to the output of more than one device. Any one of the devices then can pull the bus line to a low level without interfering with one of the other devices. Or, to express it the other way, the bus line can be in a logical true (high) state only if none of the connected devices are in the logical 0 or low state. This connection scheme is sometimes called the resistor ORing of outputs, although resistor NORing would be more correct.

The Conversational Bus

In the buses discussed thus far, the flow of information is always in one direction—from the talker or talkers to the listener or listeners. It is sometimes advantageous to use a conversational, or bidirectional, bus in which the devices alternately act as talkers and listeners, and the flow of the information changes direction.

The reason this type of bus is frequently used as a data bus in microprocessor systems is very simple. Because the microprocessor itself is nothing more than an integrated circuit, all its connections have to pass through the pins of the circuit package. The number of pins of such a circuit package is limited, however. Using the same pins for the input and output of data saves eight pins (in an eight-bit microprocessor) and makes it worthwhile to use a bidirectional data bus, even though this arrangement is slightly more complex than two unidirectional buses.

In a bidirectional bus, two special features have to be provided to ensure that the bidirectional conversation functions without problems. First, there has to be some way to indicate to all devices on the bus *in* which direction the information flow shall take place. For data buses the Read/Write (or more accurately, Read/Write) line takes care of this part.

If the microprocessor sets this line into the high state, it indicates that a read operation is taking place. That means the processor assumes the role of the listener and expects the addressed device to talk. If the microprocessor pulls this line to the low level, it indicates that a write operation takes place; the processor talks and expects the addressed device to listen.

Second, because every device can act as a talker or listener, you have to ensure that no device talks while it is supposed to listen. Because both the listen-input and the talk-output of each device are connected to the same bus, the output has to be disconnected from the bus in some way when the device is in the listen mode.

To give a specific example: The commonly used 2102 static memory has separate pins for Data In and Data Out. If you write into the device via the Data-In line, the same data appears at the Data-Out pin. If you simply connect both pins to the data bus line, all hell breaks loose. The Data-Out pin, therefore, has to be disconnected from the bus unless the Read/Write line is in the high state, indicating the processor is listening to the memory.

This disconnection of the output of devices from the bidi-

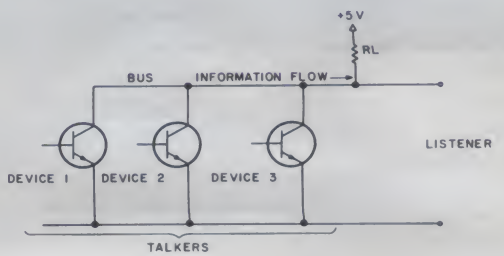


Fig. 2. The principle of the resistor-OR or wired-OR (more correctly wired-NOR) circuit.

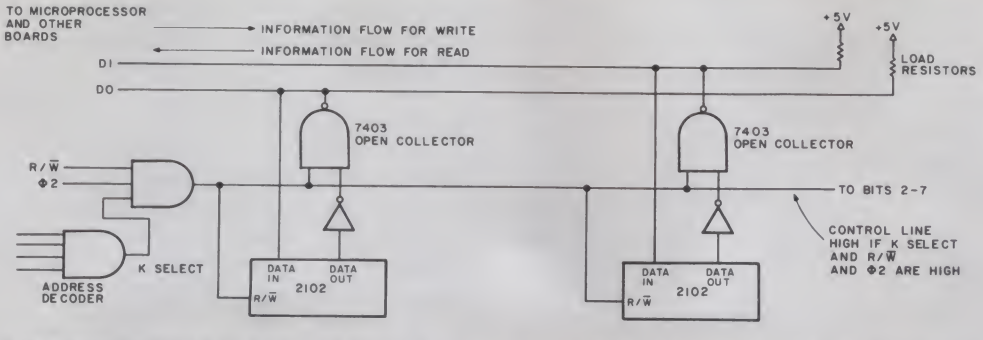


Fig. 3. A bidirectional bus system that uses open-collector gates to disconnect the Data-Out pins of memory chips from the bus during a write operation. (Only two of eight bits are shown.)

rectional bus can be achieved by the use of the resistor-NOR principle described earlier. Fig. 3 shows such an arrangement.

The output of the memory chip can control the state of the data line, but only if the control line is in a high state, which means that the processor is executing a read operation and wants the device to talk. If this line goes low, the output of the 7403 open collector NAND-gate is kept in a high state, no matter what the data output of the memory chip does. (The inverter is necessary to provide a double inversion so that the signal on the bus is identical to the one at the output of the memory chip.)

The use of the resistor-NOR technique for bidirectional buses has one limitation, however. In larger systems the capacitive loading of the bus, due to the physical length of the bus and the many devices connected to it, can be quite substantial. When the bus is supposed to go into a high state, this capacity has to be charged by the current flowing through the load resistor. This resistor, therefore, should be fairly small.

On the other hand, this means that when the bus is in the low state, a large current is drawn by the device that is driving the bus low. There is, therefore, a limit on how small the load resistor can be made and how large a bus system can be operated in the resistor-NOR mode.

This limitation can be overcome if the bidirectional bus is designed with so-called Tri-state devices. The principle of a Tri-state output can be easily understood by looking at Figs. 1a and 1b. In the totem-pole output of a normal TTL device, the two transistors A and B are alternately in the conducting and nonconducting state, thus forcing the output high or low. If, on the other hand, both transistors are in the nonconducting state, the output of the device is neither high nor low, but is in a third state in which the device is disconnected from the bus.

In order to force the device to go into this disconnect state, a special input pin is provided (labeled strobe, enable, select or control in data sheets). The polarity of this input can be such that the device is disconnected if the enable input is in the high state or if it is in the low state.

With bidirectional bus systems being more common, more and more TTL (and CMOS) devices with Tri-state outputs are becoming available. Table 1 shows the more frequently used Tri-state buffers and inverters.

A special type of device is the so-called bus transceiver. These integrated circuits contain eight inverting or noninverting buffers with a common enable input. When the enable input is high, a group of four buffers is enabled while the other four are in the disconnect state. When the enable input is low, the two groups are reversed.

By properly interconnecting the inputs and outputs of pairs of buffers from both groups, the bus transceivers can be used as an interface between a bidirectional bus and two unidirectional buses, or vice versa. They can also be used as bidirectional buffers between two bidirectional buses, as shown in Fig. 4.

There Are Buses and Buses

Most computer hobbyists, when they hear the word bus, immediately think of the S-100 (Altair) bus. Actually, the S-100 bus represents only one of several bus types around, namely, the systems or backplane bus.

The systems bus interconnects the individual circuit boards that make up the computer. Physically, a systems bus is only a number of circuit traces on the backplane that interconnect all equally numbered pins of the backplane connectors. In electrical terms —the systems bus is made up from four different sub-buses.

1. The *power bus* distributes the supply voltages to the circuit boards.

2. The *address bus* (usually 16 lines wide) is a unidirectional bus with the processor doing all the talking while all other boards are listening.

3. The *data bus*, in the S-100 bus, consists of two unidirectional buses, one for read and one for write operations, each eight lines wide. On the processor board, bus transceivers are used to interface these two buses to one bidirectional data bus that goes to the microprocessor. Most other systems buses (Heath, SWTP, OSI) use bidirectional data buses throughout the system. This partially accounts for their having fewer lines than the S-100 bus.

4. The *control bus* is made up from several different control lines—all unidirectional. In some lines the information flow is from the processor board to the rest of the system. In others, the information flow is reversed; every board can talk, but only the processor listens. The purpose of the control bus is to inform the other boards what the processor is doing. It also permits the boards to talk to the processor directly—for instance, to tell it to WAIT because the board has not yet finished an operation.

Note that the only lines of the systems bus that extend beyond the backplane are usually the ones of the power bus. Because the pulses on the signal lines are usually fast and rise times could be a problem, it is actually not possible to extend the systems bus by a couple yards in order to connect to a terminal.

The systems bus, however, is not the only type of bus that you can encounter. For example, the IEEE 488 bus mentioned earlier—also known as HP-IB (Hewlett-Packard Interface Bus, named after the company

Tri-state Buffers

Inverting	Noninverting
8T09(quad)	74125,74126(quad)
8T96,8T98(hex)	8T95, 8T97(hex)
74366, 74LS366(hex)	81LS95(octal)
74368, 74LS368(hex)	81LS97(octal)
81LS96(octal)	
81LS98(octal)	

Tri-state Bus Transceivers(all quad)

Inverting	Noninverting
8226	8216
8T26A	8T28
8T34	

Table 1. Devices with Tri-state outputs.

that introduced it), IEC-BUS, or, in Europe, EUROBUS—serves a completely different purpose. It is an *interface bus* that permits the interconnection of up to 15 different devices (computers, printers, terminals, etc.) by a single bus cable that can be up to 20 meters (about 65 feet) long.

In many applications the 488 bus might eventually replace the old RS-232C interface. This interface permits the connection of *one* terminal to *one* I/O port and, by definition, is not a bus at all. The IEEE 488 standard, a book of 80 pages, is a most comprehensive (and also most unintelligible) document, and the discussion of its details is beyond the scope of this article.

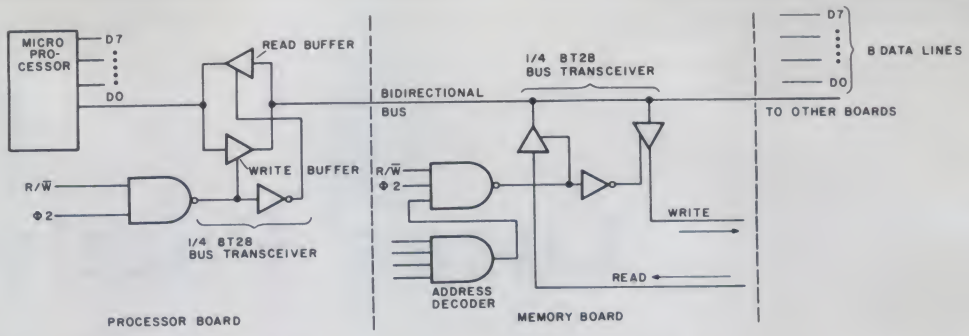


Fig. 4. A bidirectional bus system using Tri-state bus transceivers. On the processor board the transceivers are used as bidirectional bus buffers; on the memory board as an interface between a bidirectional bus and two unidirectional buses. (Only one of eight lines of the data bus is shown.)

For all buses, however, no matter what their purpose, one important rule always holds: Only one device may talk at one time. In that respect conversations between the circuit boards in a computer are not different from conversations between people: If more than one talker tries to speak at the same time, the listener—be it human or microprocessor—can become utterly confused.■

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Lucas' Puzzle

Here's a little puzzle/program that you should find interesting, n'est-ce pas?

This puzzle was invented in the late nineteenth century by a French mathematician named Edouard Lucas, hence its name. It is one of a group of games whose object is to reverse a given pattern. Generally the pattern is formed by colored pegs placed in holes in a board. This game is one of the simplest of this type.

First, a marker (in the program the markers are asterisks or the letter X) may only be moved into the empty space. There are two ways to do this: either *slide* the marker into the adjacent empty space or *jump* a marker over another marker into the space. Second, asterisk markers move only to the right; X markers move only to the left.

To make a move simply enter the number above the marker to be moved, a comma and the number above the space. You win when all the X markers have been moved to the left end and all the asterisks to the right leaving a space (shown by an O) in the middle.

The puzzle can be solved in 24 moves, but it can get quite tricky; it's easy to get into a position that's impossible to get out of. ■

```
10 INPUT"INSTRUCTIONS?",I$
20 IF I$(1,1)="Y" THEN GOSUB 500
30 DIM B(9)
40 FOR I=1 TO 4
50 LET B(I)=1
60 NEXT I
70 LET B(5)=0
80 FOR I=6 TO 9
90 LET B(I)=10
100 NEXT I
110 LET M=0
120 PRINT"THE BOARD AFTER MOVE";M
130 PRINT ""
140 PRINT ""
150 PRINT" 1 2 3 4 5 6 7 8 9"
160 PRINT ""
170 FOR I=1 TO 9
180 IF B(I)=0 THEN PRINT" 0 ";
190 IF B(I)=1 THEN PRINT" * ";
200 IF B(I)=10 THEN PRINT" X ";
210 NEXT I
220 PRINT ""
230 PRINT ""
240 INPUT "YOUR MOVE?",X,Y
250 IF X=99 THEN GOTO 760
260 GOSUB 350
270 IF F=1 THEN GOTO 240
280 LET B(Y)=B(X)
290 LET B(X)=0
300 FOR I=1 TO 4
310 IF B(I) <> 10 THEN EXIT 340
320 NEXT I
330 IF B(5)=0 THEN GOTO 770
340 GOTO 110
350 LET F=0
360 IF B(Y) <> 0 THEN GOTO 470
370 IF B(X)=10 THEN GOTO 440
380 IF B(X)=1 THEN GOTO 410
390 IF B(X)=0 THEN GOTO 470
400 GOTO 470
410 IF X >=Y THEN GOTO 470
420 IF Y-X >2 THEN GOTO 470
430 RETURN
440 IF X <=Y THEN GOTO 470
450 IF X-Y > 2 THEN GOTO 470
460 RETURN
470 PRINT"ILLEGAL MOVE. REENTER."
480 LET F=1
490 RETURN
500 PRINT "" : PRINT ""
510 PRINT"          LUCAS' PROBLEM"
520 PRINT "" : PRINT ""
530 PRINT"THE OBJECT OF THIS GAME IS TO"
540 PRINT"EXCHANGE THE POSITIONS OF THE "
550 PRINT"TWO SETS OF MARKERS; * AND X"
560 PRINT"TO DO THIS YOU MUST MOVE THEM"
570 PRINT"INTO THE SPACE MARKED WITH AN"
580 PRINT" '0'. THE MARKERS MAY BE MOVED"
590 PRINT"EITHER INTO THE '0' SPACE"
600 PRINT"IF IT IS ADJACENT OR A SINGLE"
610 PRINT"MAKER MAY BE JUMPED."
620 PRINT"THE '*' MARKERS MOVE ONLY"
630 PRINT"TO THE RIGHT AND THE 'X' ONES"
635 PRINT"ONLY TO THE LEFT."
640 PRINT ""
650 INPUT"RETURN TO CONTINUE.",I$
670 PRINT"" : PRINT"A MOVE IS MADE BY ENTERING THE"
680 PRINT"NUMBER ABOVE THE MARKER TO BE MOVED"
690 PRINT"AND THE NUMBER OF THE SPACE"
700 PRINT"TO WHICH IT IS TO BE"
710 PRINT"MOVED. THE PUZZLE CAN BE SOLVED"
720 PRINT"IN 24 MOVES."
730 PRINT ""
740 INPUT "RETURN TO PLAY.",I$
750 RETURN
760 END
770 PRINT"CONGRATULATIONS, YOU DID IT."
780 END
```

Program listing.

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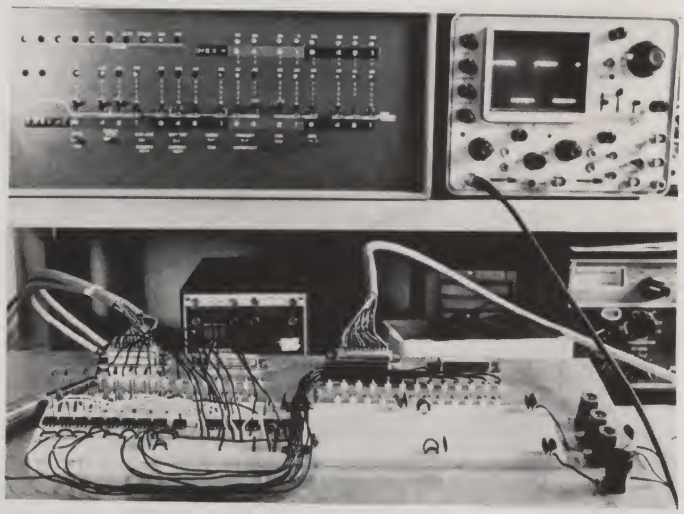
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Home Brewing in Style

In computing's construction kitchen, why don't you give solderless breadboarding a try in your next recipe.



The breadboard in use, showing a portion of an 8-bit parallel interface for a high-speed paper-tape reader.

One area of hobby computing badly in need of development is that of tools and gadgets designed to make life easier for the hardware home brewer. Pretty boxes and single-board computers dominate the market to such an extent that home brewing hardly seems worth it. Now don't get me wrong — there's a lot to be said for those pretty boxes; I own one myself. They just don't lend themselves too well to home brewing.

Sure, there are a lot of prototype (mostly wire wrap) cards available for Altair bus systems and others. But I don't relish the idea of wrapping and unwrapping a bunch of connections on a board sticking out of the top of my Altair during the course of developing a particular interface or peripheral circuit.

It just so happens that there *is* a better way — the use of "solderless breadboard" sockets. The principle of the solderless breadboard is simplicity itself. An array of contacts is held in a molded nylon block full of holes on .1 inch centers, the standard lead spacing for most DIP ICs. These contacts are bused together to provide numerous isolated multicontact tie points. The contacts are designed to accommodate such things as IC pins, discrete component leads, or 22-gauge solid hookup wire. One simply inserts the desired component or lead in a hole, and the springy metal contact material grabs it, insuring a physically secure electrical connection.

Breadboarding

I would guess that most computer hobbyists have seen the *Bugbooks* . . . a kind of lab workbook on microcomputers. The companion to the series is an 8080 system incorporating its own integral breadboard. No hidden stuff going on inside a pretty box there; it's *all* hanging out in the open! This was my inspiration for a better computer prototyping configuration. Since I already had a computer and wasn't about to buy another one, my goal was to bring the breadboard to my existing system.

When I first began designing add-ons for my Altair, I tried using a general-purpose logic prototyping system (built around a pair of solderless breadboards) that I had devised several years ago. It afforded me plenty of flexibility and room for the simple circuitry I was developing, but before long I was having to contend with a mess of wires running between the computer and the breadboard. Any circuit handling parallel data, sync and status lines, etc., can rapidly develop into an unmanageable tangle.

After studying the problem for a while, I realized that one thing I had going for me was that the Altair uses a standardized connector for all I/O. So at least I could make up a standard set of interconnect cables for breadboarding. Still, there was the problem of how to get all those lines neatly on and off the board.

Fortunately, I had had previous experience with an E&L Instruments product, the BP-22 solderless turret terminal. It provides the same type of individual solderless connections as the breadboard. On the completed prototyping system, two sets of 25 of these terminals allow me to selectively make easy connections to two pairs of DB-25 connectors. Each pair consists of a plug and a socket with like pin numbers wired together. This arrangement affords me a degree of flexibility of interconnection and has proved itself most useful in the design of circuits that connect the computer and an external device. Additional turret terminals wired to color-coded binding posts provide for power-supply connections.

A 17 x 8 x 2 inch aluminum chassis serves as a base for the system. Although I have thus far found two solderless breadboards to be adequate, the chassis is laid out in such a way as to permit the addition of two more. Except for the wiring between the turret terminals and connectors, the underside of the chassis is empty. There is plenty of room for power supplies, pulse generators, or whatever; I elected to keep the whole thing as simple and as passive as possible.

A word about bringing bus

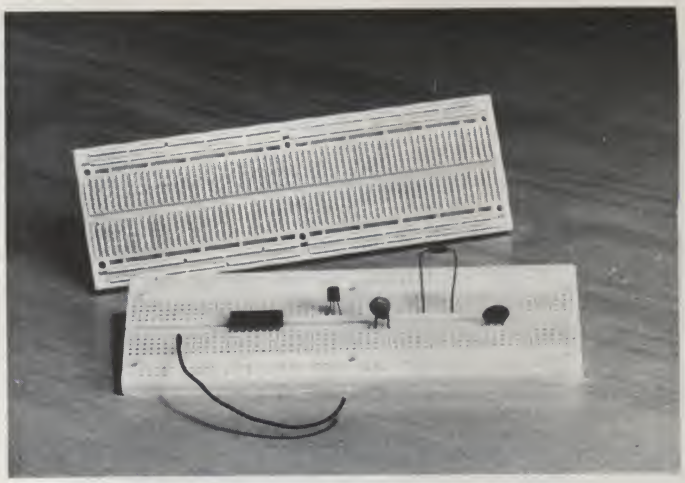
lines out of the computer cabinet is in order. *Don't* indiscriminately wire bus signal lines to a rear-panel connector. Unless they are properly terminated, bringing such lines out of the cabinet will usually result in the introduction of extraneous noise on the bus, and we all know what that means — trouble. Since different system buses have different electrical characteristics, bus termination techniques will vary from machine to machine. It would be best to contact the manufacturer of your computer for his recommendations.

Precautions to Follow in Breadboard Use

Regarding the use of the breadboard itself, there are a few precautions that one should observe. First, people tend to get rather sloppy when using a solderless breadboard. Connections are made so easily and quickly that it takes a conscious effort to prevent the thing from looking like a convention of spiders. Believe me, though, the time taken to lay out a circuit neatly is well spent, resulting in a saving of grief and headaches during the troubleshooting phase of the design process. One of the best ways to insure neatness is to plan the layout before you begin. It also helps to keep an ample supply of various lengths of prestripped color-coded number-22 solid hookup wire handy.

The second thing to remember is that a breadboard — any breadboard — is going to be more noise prone than a PC card design. This is particularly true of TTL circuitry handling fast rise-time signals. So use *lots* of bypass capacitors.

Finally, we all do make mistakes. Invest in some fire insurance — be certain that the power supply you use to feed the breadboard is short-circuit protected and current limited! ■



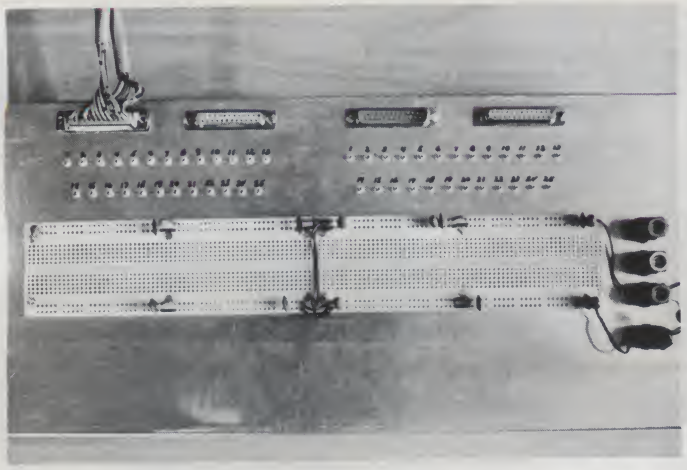
Top and bottom views of the "solderless breadboard." The bottom view clearly shows the contact busing arrangement.



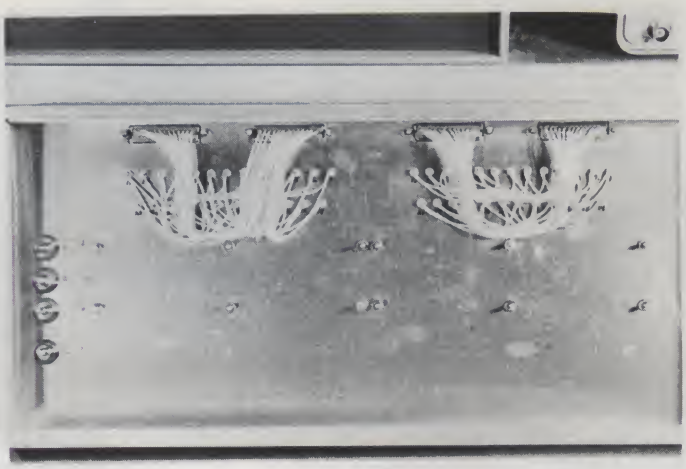
The solderless turret terminal prior to installation.



Detail of several solderless turret terminals mounted and in use.



Top view of computer prototyping breadboard system.



Bottom view of computer prototyping breadboard system.

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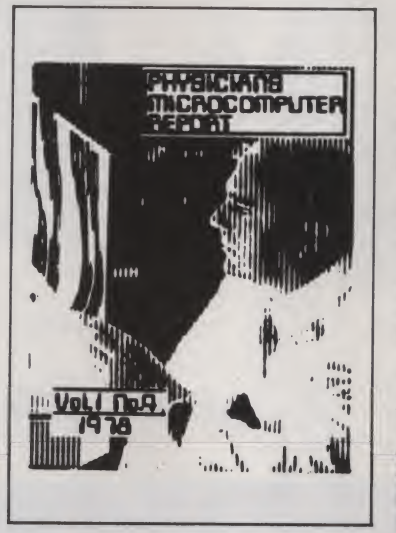
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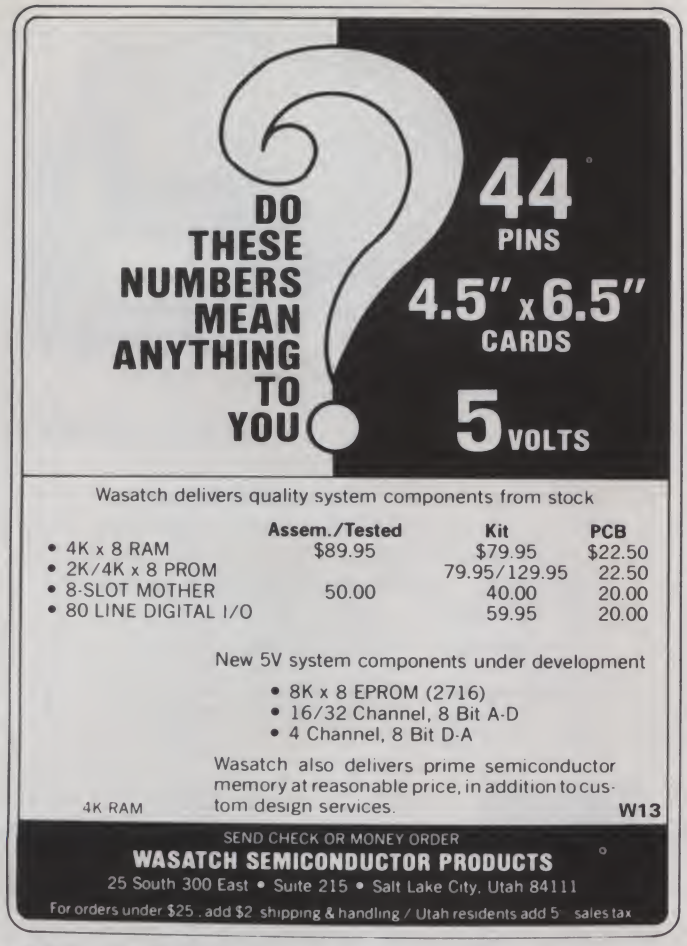
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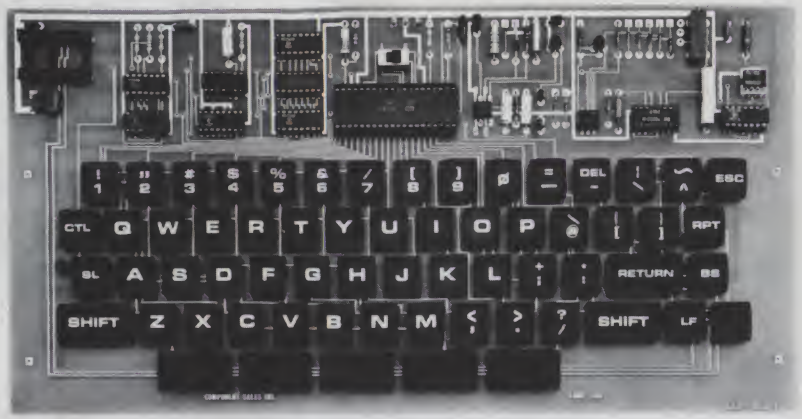
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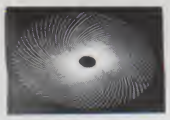
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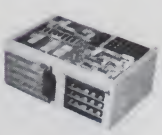
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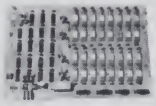
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Modify Your COSMAC Elf

This modification to the Elf involves a lilliputian outlay of cash.

The COSMAC Elf microcomputer described in *Popular Electronics* (August and September 1976) has been one of the most interesting projects I've built. However, soon after wiring it together and running a few programs, it was obvious that I spent a lot of time loading programs by the eight front-panel toggle switches. And the frustrating part occurred when I would make an error at step 200, for example, and the only way to get back to that step was to press the In button 199 times and then make the correction. In subsequent issues of *Popular Electronics*, programs to interface the microcomputer with a keyboard and allow the machine to jump to a requested memory location to make a correction there were published. After looking over these programs, I decided they were not for me.

First, you have to enter them using the eight front-panel toggle switches at the beginning of every program, which takes about 10 or 15 minutes every time you turn the computer on. Second, this program takes up valuable memory space; in fact, it uses 74 of the 256 available bytes in the memory. If you want to expand your memory, the latter may not concern you as much. Consequently, I devised the following circuit that interfaces a keyboard with the microcomputer and also allows you to jump to any desired memory location very quickly. The circuit requires no programming and uses no memory space.

Construction

The circuit was constructed on a 4 x 8 x 2 inch aluminum chassis. The chassis is turned upside down (open side up), and a piece of perfboard with a grid of 0.05 x 0.05 inch mounts over the open side using sheet metal screws; a second piece of perfboard with a 0.1 x 0.1 inch grid mounts inside the chassis. The hexadecimal keyboard was purchased from James Electronics, and the spacing of the pins conforms more or less to the 0.05 inch grid. A few extra holes had to be drilled to make it fit exactly into the perfboard. ICs 1,2,3,4 and 10 mount on the top perfboard with the

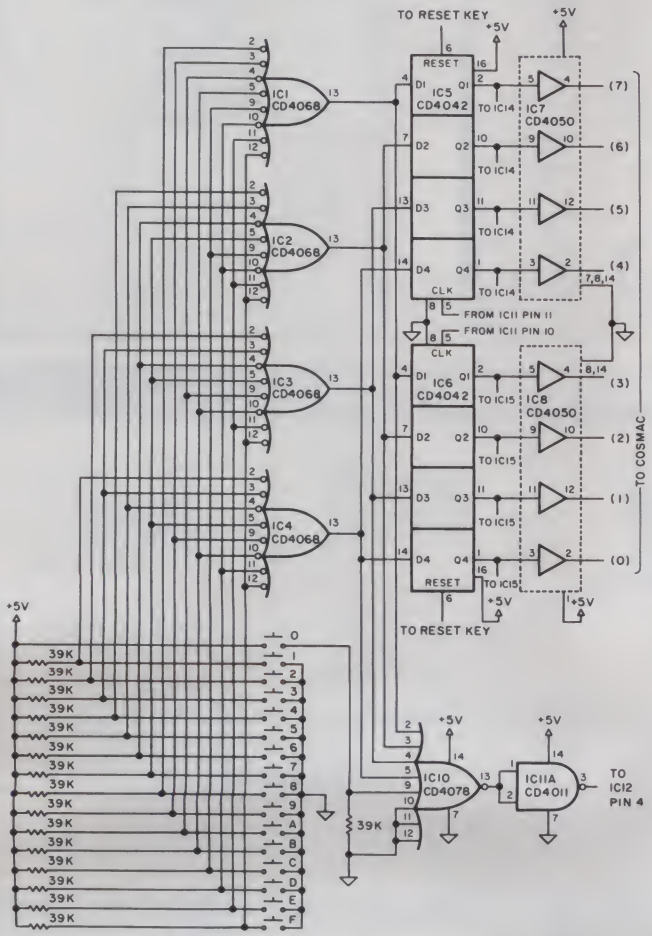


Fig. 1. Keyboard encoders and latches.

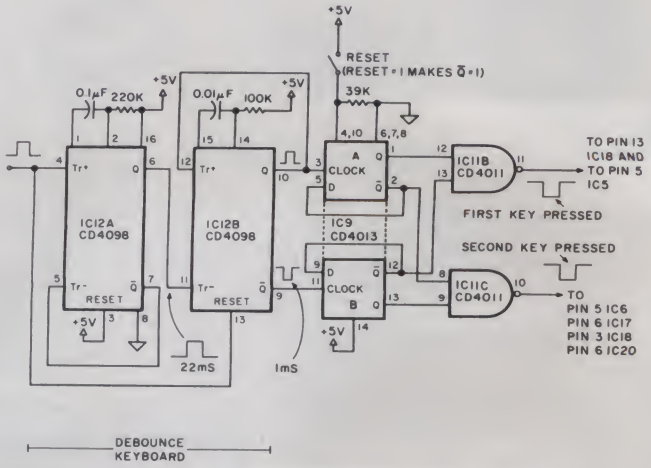


Fig. 2. Debounce and strobe circuits.

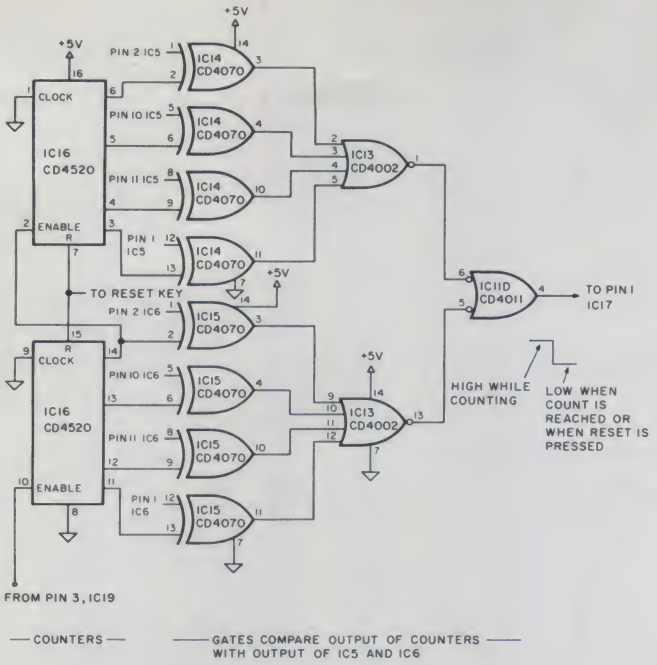


Fig. 3. Counter and compare circuits.



Right: The COSMAC Elf. Center: Keyboard support circuitry with top removed and shown at the left.

keyboard; the remaining ICs mount on the second perfboard. IC sockets were used throughout, and wiring was accomplished by working several evenings using a Vector wiring pencil. The keyboard has several uncommited keys, one of which you must designate as a reset.

Circuit Description

ICs 1, 2, 3, 4 (Fig. 1) produce the proper code for each key pressed; e.g., when D is pressed you get 1101. IC10 detects the closure of any key, and its output is inverted by IC11A, which feeds a debouncing circuit made up of the two monostable multivibrators in IC12. IC12A (Fig. 2) triggers on the rising edge of the input, sending out a 22 ms pulse. Assuming that all contact bounce is over in less than 22 ms, IC12B will trigger on the falling edge of this 22 ms pulse and send out a 1 ms pulse. When the key is released, IC12A may or may not generate another 22 ms pulse, depending on how bad the key bounce is. IC12B will not be triggered by this pulse because triggering occurs only on the falling edge, which does not occur until 22 ms after the key has been released. The moment the key is released, the low signal on the reset of IC12B prevents triggering. In summary, IC12 generates a single 1 ms pulse for each keystroke.

IC11B produces a 1 ms pulse on the first keystroke that gates the outputs of ICs 1, 2, 3, 4 into IC5, which then stores the binary code for the first key. IC11C produces a 1 ms pulse on the second keystroke that gates the outputs of IC1, 2, 3, 4 into IC6, which then stores the binary code for the second key. At the same time, this pulse goes to pin 3 of IC18, which inverts the pulse and signals COSMAC that the data is ready to go into memory. The pulse is not synchronized to COSMAC's internal timing, but it lasts much longer than a timing cycle, guaranteeing that the memory will get the data. The third and fourth keystrokes behave like the first and second, a pulse going out after the fourth to signal that the data is ready again. The whole operation is fully automatic, and there is never any need to press the input button. IC7 and IC8 are buffers required to drive the COSMAC circuitry.

Figs. 3 and 4 show the circuit I devised to advance to any desired step in the program. In effect, all these circuits do is push the input button the required number of times to get to whatever program step you enter on the keyboard. For example, you want to go to step OB — so you press reset, set memory protect, reset COSMAC with the load switch and enter OB. IC19 will send out 12 pulses, which, through IC18, advance to step OB. IC19 oscillates at 1000 Hz, so the time to get to the last step in the program, FF, is about 256 ms. All other steps will be reached in less time.

IC19 drives the first four-stage binary counter in IC16, and the output of this counter drives the second one. Together these can count to any desired value from 00 to FF, and their outputs are in binary form. Let's say you enter B7 on the keyboard. IC19 starts oscillating and IC16 starts counting the pulses. IC14 and IC15 compare the output of the counters to the B7 stored in IC5 and IC6; when the counters get to B7 a signal is sent out via IC13, IC11D and IC17 to stop IC19. IC19 sends out exactly 183 pulses, and assuming *COSMAC was*

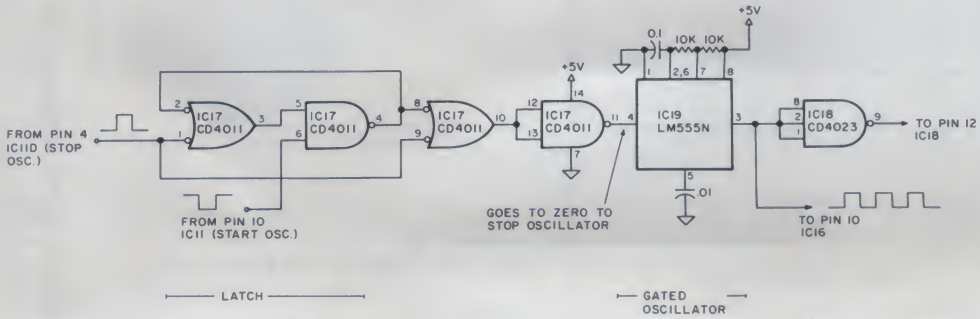


Fig. 4. Oscillator circuit.

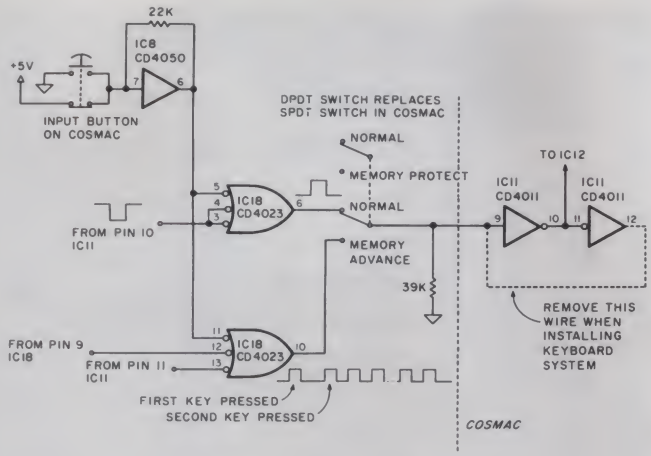


Fig. 5. COSMAC interface.

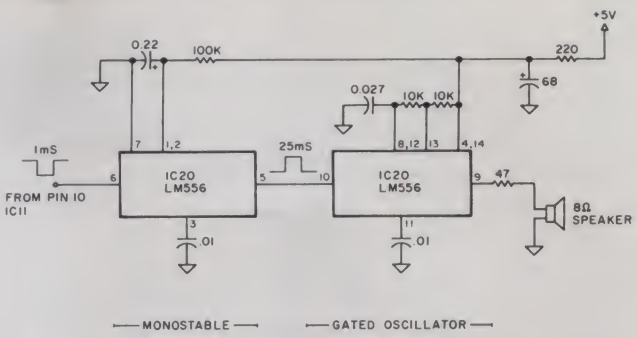


Fig. 6. Optional circuit to provide beep on every second keystroke.

at step 00 initially, you would arrive precisely at step B7. In Fig. 5 it will be noticed that at pin 10 of IC18 you get one extra pulse from the first keystroke. This is needed to set the program back to step 00, and it eliminates the need to press the input button.

Fig. 6 shows an optional circuit that provides an audible beep on every second keystroke. The reason for including this is that sometimes when your are entering a lengthy program you will strike a key, but not press it hard enough to actually make the contact. You go on your merry way, not realizing your mistake because you haven't been looking at your hex display. You end up having the last digit of each entry paired with the first digit of the following entry. It's quite a mess, believe me!

IC20 is a dual timer, the first half of which stretches that 1 ms pulse into a 25 ms pulse. The second half is connected as an astable multivibrator driving a loudspeaker. It is gated on for 25 ms and gives a beep. A 68 uF capacitor and 220 Ohm resistor decouple this circuit from the 5 volt line and reduce current consumption. If a longer beep is desired, increase the 0.22 uF capacitor. If a different pitch is desired, change the 0.027 uF capacitor. Any speaker will probably do; I used a 2-inch one from Radio Shack.

Modification of COSMAC Circuitry

The eight front-panel switches must be disconnected. The outputs of IC7 and IC8 in Fig. 1 are connected in their place. The memory-protect switch must be replaced with a DPDT toggle switch, one-half of which is wired up as in the original, while the other half is wired as shown in Fig. 5. The input button is rewired as shown and is debounced by an unused part of IC8. As shown, you must remove the wire joining pins 9 and 12 of IC11 in COSMAC.

Using the System

To enter data into memory, press reset, set COSMAC to load and start using the keyboard. To check what you've entered at a particular step set memory protect, reset the load switch and leave on load, press the reset key and enter the step you want to see on the keyboard. You can then change the data in the following step by just switching off the memory protect and keying in whatever you want.

The input button behaves as it did in the original design, and it can be used if the program calls for it to be pressed; or it can be used to advance the memory one step at a time.

Summary

The whole project cost me around $55 here in Canada where prices tend to be higher. It has been worth every penny in the increased convenience and speed it provides in programming. ■

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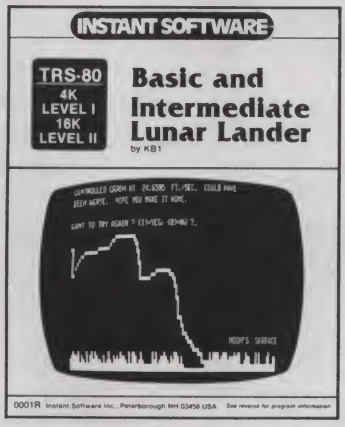
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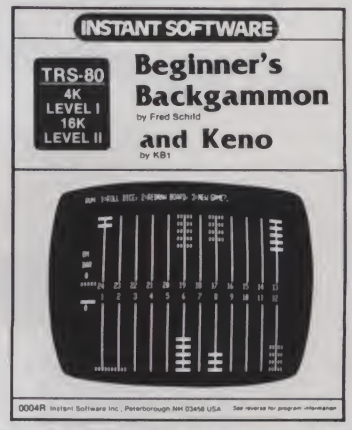
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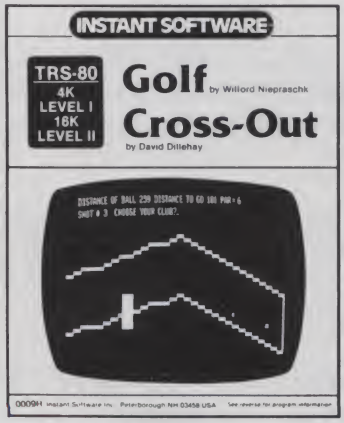
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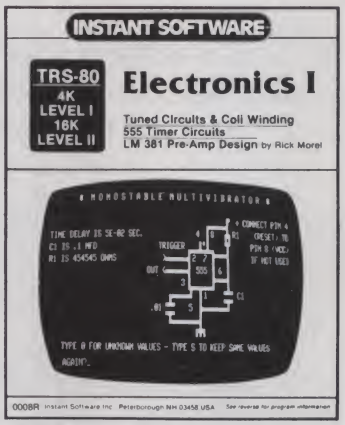
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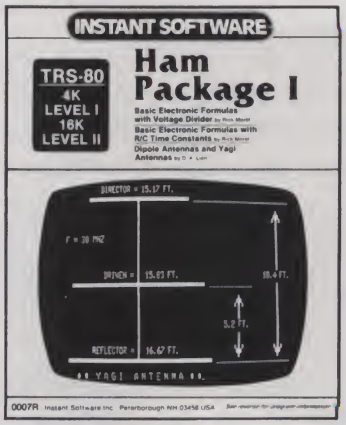
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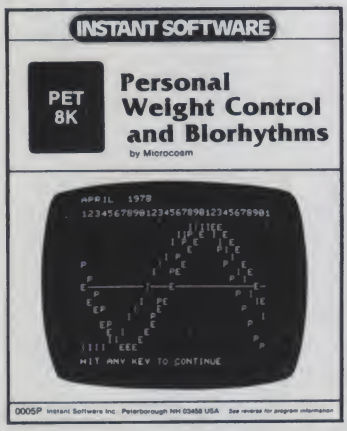
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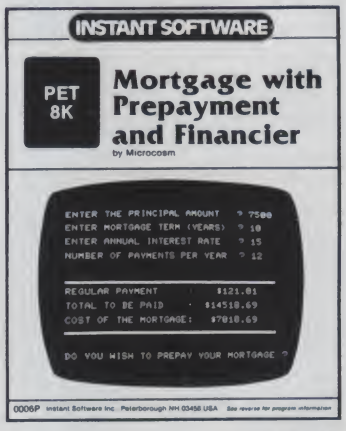
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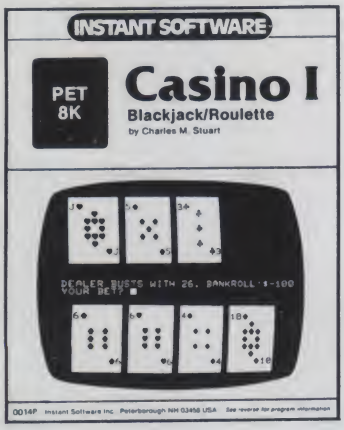


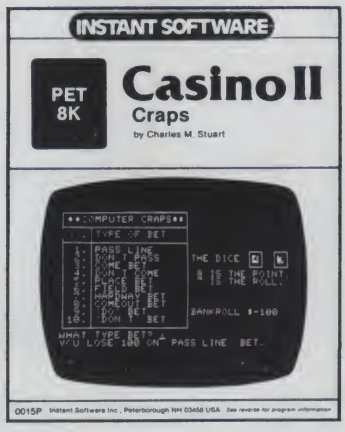


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Loop the Loop

What is a loop? How do you use it? The neophyte gets this and other questions answered in this informative article.

James Gross
University of Wisconsin Center
Sheboygan WI 53081

One of the most powerful abilities of a digital computer is to repeat a series of program steps until a specific condition occurs. This is called *iteration*, or looping. We will look at how loops can be used. Examples will be given in BASIC, but the principles apply in any language.

In the paragraph above, a key phrase is "until a specific condition occurs." Otherwise, you have a loop that repeats forever. Home computing systems usually have a BREAK function, which can get you out of a perpetual-loop condition, or you can always halt the computer completely. On a larger commercial system, however, these options aren't always available. Most programmers would agree that you should avoid such "infinite loops."

To see the problems they can cause, try the short program in Example 1 (the idea comes from an old joke).

It soon becomes evident that the program is out of control! What this program lacks to have a controlled loop is, of course, a terminating condition.

The simplest and most common technique in loops is a numeric counter, or *index*, to control the number of repetitions. The index is set, usually to value 1, before the loop. After the useful steps occur, the index is increased, or *incremented*, by 1 and then tested against the limit. (I will use explicit incrementing and testing to demonstrate the principle, though all high-level programming languages have special instructions to accomplish these functions: BASIC has FOR-NEXT, FORTRAN has DO, and so on.)

As an illustration of the simple numeric index, suppose we want to compute and print the squares of the numbers one through ten (see Example 2). Lines 15 and 20 are the heart of this program; the other lines control the iteration. Line 10 initializes the index to 1, line 25 increments it by 1, and line 30 tests for the terminating condition.

Note that because we want the squares of 1 *through* 10, and because we increment X *before* the test, X will equal 10 in line 30 just after we've printed the X = 9 answer. This means one more cycle is needed, computing and printing 10, then making X equal 11, which makes X< = 10 false, and ending the program.

I have two additional comments about Example 2. First, I call it a one-shot program because it always does the same thing: If it runs a second time, it produces a second copy of the same table. In my opinion, that's the function of a photocopy machine, not a computer. The program could easily be made more flexible by modifying it to take in a limiting value (call it E for ENDING) and comparing X with E. The changes that would be made are shown in Example 2a.

```
 5 REMARK EXAMPLE 1, INFINITE LOOP
10 PRINT "COMPUTERS ARE PERFECT. NOTHING CAN "
15 PRINT "GO WRONG."
20 GOTO 15
25 END
```

Example 1.

```
 5 REMARK EXAMPLE 2, SQUARES USING A COUNTER
10 LET X = 1
15 LET Y = X * X
20 PRINT X, Y
25 LET X = X + 1
30 IF X<= 10 THEN 15
35 END
```

Example 2.

```
 6 PRINT "WHAT ENDING VALUE";
 7 INPUT E
30 IF X<= E THEN 15
```

Example 2a.

```
 5 REMARK EXAMPLE 3, TEMPERATURE CONVERSION
10 LET F = 90
15 LET C = INT (5 * (F - 32) / 9)
20 PRINT F, C
25 LET F = F - 5
30 IF F>= -40 THEN 15
35 END
```

Example 3.

Now the program will compute and print the squares of values 1 through E. I'd like you to try to make one more alteration to generalize it further—take in the starting value also. Then if you need the squares of values between 5126 and 5300, you don't have to wade through the 5125 extra lines of printout!

My second comment on this program concerns the increment of + 1 we used. If your application requires it, the increment can be negative, so that the loop counts down instead of up. A good example of this is printing a Fahrenheit-to-Celsius temperature conversion chart (see Example 3) with the Fahrenheit temperatures running down the left edge from + 90 to − 40 in 5 degree steps. (A negative quantity added to a counter is called a *decrement*.)

Note that the test in line 30 fails when F is *less than* − 40; that's what we want because we're working downward. The integer (INT) function in line 15 insures that the Celsius temperatures are whole numbers.

In the preceding examples, the terminating condition has been the value of the index, but this doesn't have to be the case. One common way of terminating a loop containing an INPUT or READ, for instance, is to use a special target value (also known as a trigger or sentinel) whose only purpose is to terminate the loop. It is useful in cases where several input data values must be processed, but the exact number of them isn't known. Let's see how *this* works in an inches-to-centimeters conversion (see Example 4).

This program will take in a length in inches and print the

equivalent centimeter value, repeating until a negative value is entered. In the case of linear measure, a negative value makes no sense, and this "illegal" condition is ideal to use as a target. In applications where either positive or negative values can legitimately occur, the target value used is either an extreme value (temperature over 10000) or a very unlikely value (length exactly 999.9 inches).

In computer use, the greatest impact of iteration is in calculations involving a so-called convergence technique, in which each cycle computes a closer and closer approximation to a desired value. A practical application of this technique is approximating the square root of a number using the Newton-Raphson method.

Suppose we're looking for the square root of a value named X. We begin by guessing that the square root of X is a value, G. Next, we compute the *quantity* ½(G + X/G). This becomes the new value of G, the computation is repeated to get another G, then another, and so on. Each G value will be closer to the actual square root of X than the previous G. The loop can be made to terminate when G squared is "close enough" to X. The exact definition of close enough depends on the problem and the specific computer's precision. Let's work through a sequence by hand to see this convergence technique work.

```
 5 REMARK EXAMPLE 4., METRIC LENGTH WITH TARGET VALUE
10 INPUT L
15 IF L<0 THEN 35
20 LET M = L * 2.54
25 PRINT M
30 GO TO 10
35 END
```

Example 4.

Assume we want the square root of 110. Ten squared is 100 and 11^2 is 121, which suggests a value between 10 and 11. However, to observe progress toward the answer, let's make our initial guess 25. Substituting X = 110 and G = 25 in the formula, we compute a new G (see Example 5). Using that new G, we continue in Example 6.

```
G = ½ (25 + 110/25) = 14.7 Cycle 1
```

Example 5.

In just four cycles, the square root has been found.

```
G = ½ (14.7 + 110/14.7) = 11.091 Cycle 2
G = ½ (11.091 + 110/11.091) = 10.5044 Cycle 3
G = ½ (10.5044 + 110/10.5044) = 10.488 Cycle 4
```

Example 6.

Utilizing this technique in a program, your initial guess can be any nonzero value. In fact, it can be the value whose square root you're finding! (See Example 7.)

```
 5 REMARK EXAMPLE 7, SQUARE ROOTS BY NEWTON
10 PRINT "WHAT VALUE";
15 INPUT X
20 LET G = X
25 LET X = .5 * (G + X/G)
30 PRINT X
35 IF ABS (G/X - 1)>.0001 THEN 20
40 PRINT "THE SQUARE ROOT IS "; X
45 END
```

Example 7.

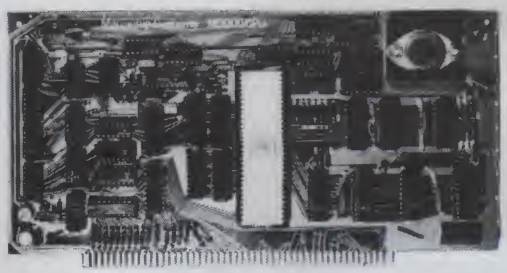
Here, line 30 lets you watch the value change. In a program that used this technique, you would probably just want to use the answer. Line 35 repeats the loop until the difference between successive guesses is small. Asking this program to find the square root of 110 (using 110 as the first guess) gives subsequent values of 55.5, 28.741, 16.2841, 11.5196, 10.5343, 10.4882, and 10.4881 as the final result. Adding some analytical steps to get a better first guess would make it converge even faster.

I have tried to show you some of the uses of loops, some of the dangers and some of the various styles. Once you understand the idea, they are easy to design. Your programs will often be physically smaller with loops than without, and the principles can be applied in any language. Try writing your own programs incorporating what you've learned here. I think you'll enjoy it.■

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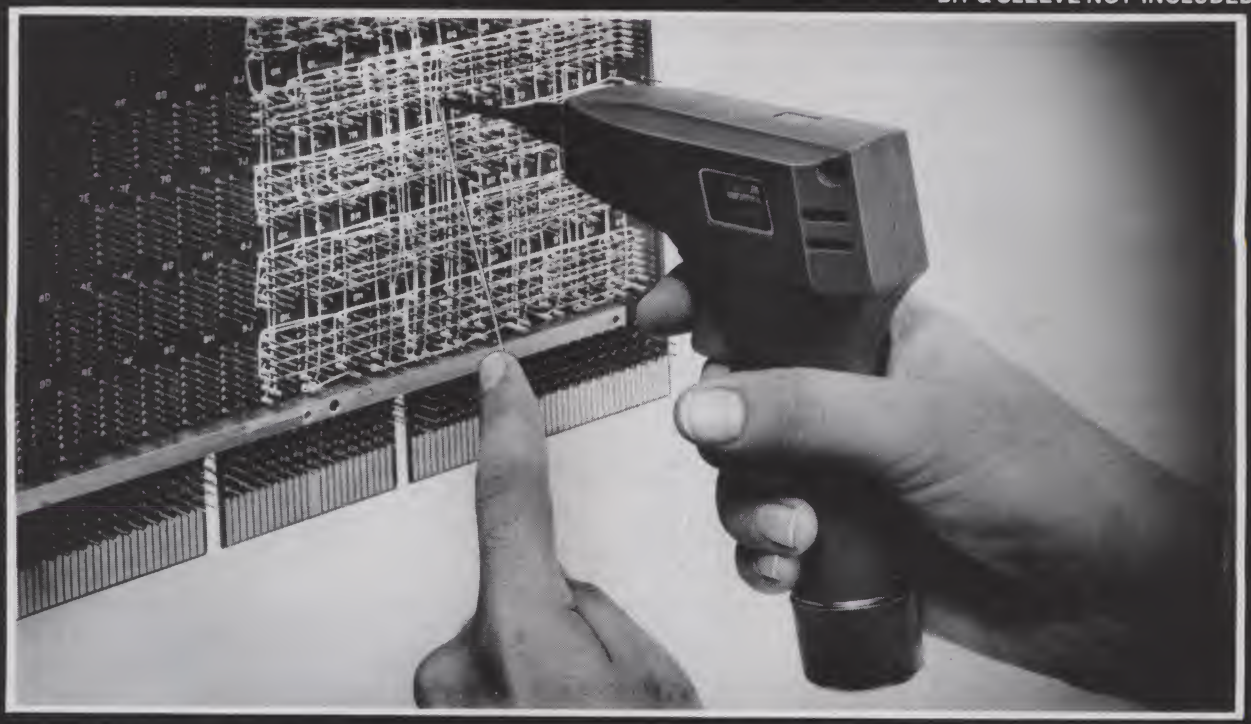
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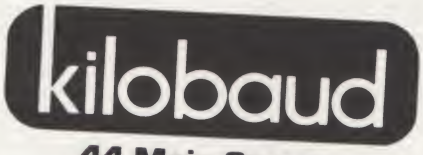
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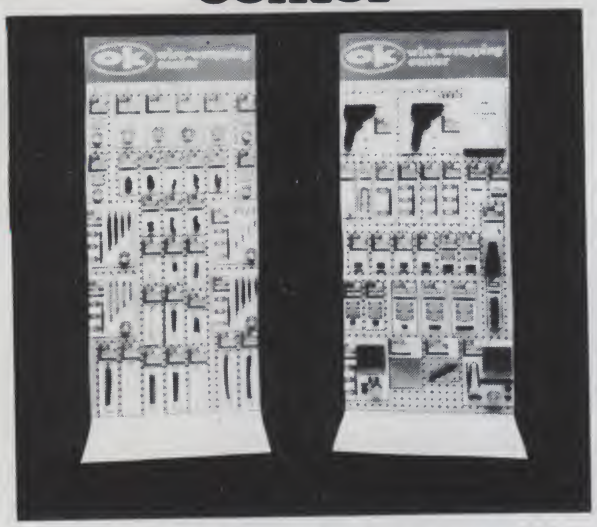
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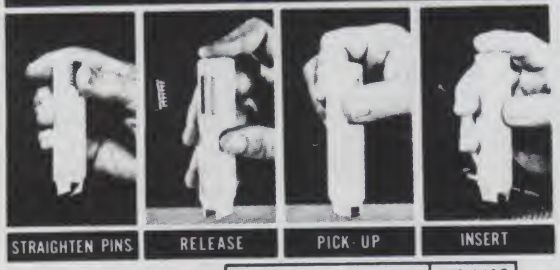
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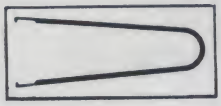
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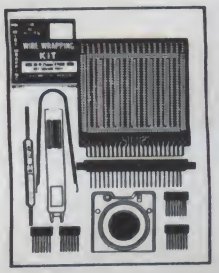
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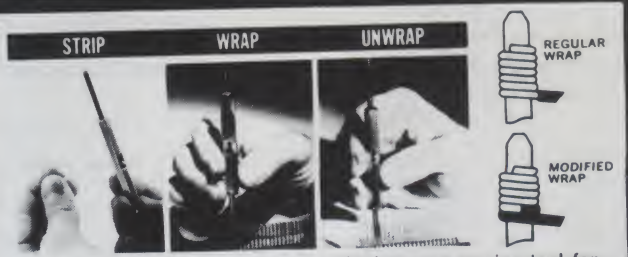
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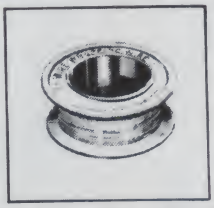
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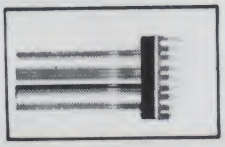
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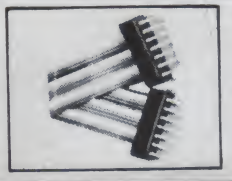
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TRS-80 Monthly Newsletter. For information write to: Howard Y. Gosman, Box 149, New City NY 10956.

•Books of computer games in BASIC. ENIGMAS-1 ($8): Gone Fishing, Concentration, Starship, Craps, Slot-Machine, Sherlock Holmes, Tank Attack. ENIGMAS-2 ($8): Number Guess, Mortar Battle, In-Between, Shell Game, Safari, Starship-2, Dice Roll, Puzzle. •Catalog and test program Frog Race, $1. Available in Standard BASIC, SWTP 8K BASIC or Radio Shack TRS-80 BASIC. Please specify. B. Erickson, PO Box 11099, Chicago IL 60611.

CIRCLE CHESS instruction book by Alphonso, used in Circle Chess software development, $5. Stanonis, Box 63, Des Plaines IL 60017.

TRS-80 Level II, 16K. Star Trek game that runs in Level II, $5.95. Other games SASE. J. Joyce, 5925 Rockhill Rd., Kansas City MO 64110.

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Must Sell!! SOL 20—24K RAM—Panasonic monitor, cassette—North Star controller with Shugart SA400 disk drive—music interface board—15K extended cassette BASIC—12K disk BASIC—game pack 1—everything works—less than 6 months old—$3400 value for $2995 J. Andrews, 6303 Kury, Houston TX 77008. (713) 869-3985 (eve.)

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For Sale: Apple II software-cassette: Author-Title Index program for books, records, tapes. Super-fast machine-lang. sort. 16K Blackjack, graphic, paddle input, sound, full L. V. rules, auto-play by computer: $10 each incl. doc. Both for $15. George W. Lee, 18803 S. Christina Ave., Cerritos CA 90701.

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Software: Apple II programs from Astro-Graphics Software. 16-color Life game, $6.50; Hires drawing program (draws & saves any shape), 16 & 20K, $12; astrology calculation program (Ephemeris needed), $10; Number converter bases 2-16, $5; graphics package, $3; robots game, $7.50. Send for current list to: AstroGraphics Software, 140 Willow Ave #2, Fairfax CA 94930.

Contest!

If you've been following our "best article of the month" contest, you know that we'll be putting a year's worth of winners on a ballot, and the winner in that balloting will win $500.

The contest started with the October 1977 issue; the winner for August 1978 has been chosen already, which means we have one month to go. September's winner and the ballot will appear in the next issue.

So—dust off your back issues and get ready to make one of our authors $500 richer.

By the way, the winner for August is Donald L. Fitchhorn, author of "DOCUFORM," by a landslide.

The winner in our drawing of all votes submitted is John S. Turner of Monroe MI. He wins a book from the KB Book Nook.

Congratulations, Don and John, and thanks to all our readers who have responded so enthusiastically with their votes.

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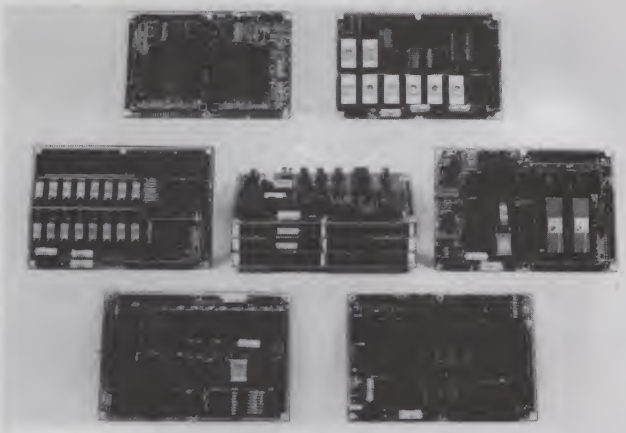
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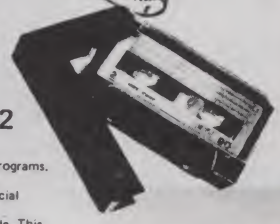
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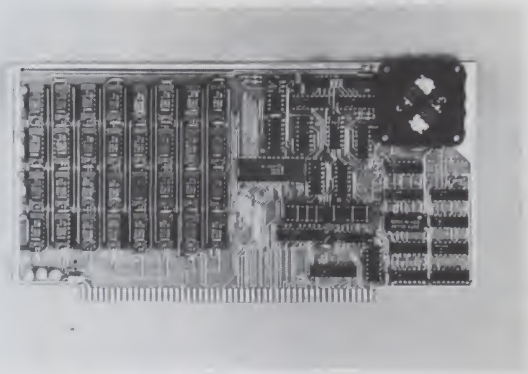
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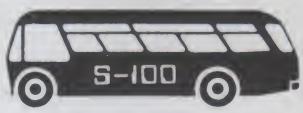
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TRS-80 SOFTWARE

THE ELECTRIC PENCIL WORD PROCESSOR - $99.95

THE ELECTRIC PENCIL, highly respected as a superior word processor for home computers and small businesses, is now available for the TRS-80 computer! In addition to all standard **ELECTRIC PENCIL** features (free format entry, line and character insertion and deletion, forward and reverse scrolling with speed control, string search, coded search, search and replace, block moves, inserts, and deletions, fully formatted print contol, page titling and numbering, etc., etc.), the TRS-80 version offers the following features: transparent cursor, two-key rollover, repeating keyboard, uppercase only in unmodified TRS-80's, or upper and lowercase entry and display after simple modification (documentation included).

THE ELECTRIC PENCIL runs printers using Radio Shack's expansion interface or will operate any RS-232 300 baud printer using our **TRS232** printer interface. Either LEVEL-I or LEVEL-II 16K computers may be used! **THE ELECTRIC PENCIL** opens a whole new world of practical applications for the TRS-80 computer!

RSM-1S: A MACHINE LANGUAGE MONITOR FOR THE TRS-80 - $23.95

NEW! RSM-1S IS NOW AVAILABLE ON FLOPPY-DISK FOR $29.95!! RSM-1S provides you with 22 commands which interact directly with the Z-80 processor in your TRS-80. You may examine your ROM's, test your RAM, enter and execute machine language programs, read and write machine language tapes, and much more! A **SYMBOLIC DUMP** command disassembles object code and displays it as Zilog standard Z-80 mnemonics! Memory may be displayed in HEX or either of two ASCII formats, and can be EDITED, MOVED, EXCHANGED, VERIFIED, FILLED, ZEROED, TESTED, or SEARCHED for one or two-byte codes. Memory display commands may be stepped with SPACE, or aborted with BREAK. Runs in 4K.

AIR RAID: A REAL-TIME TRS-80 SHOOTING GALLERY! - $14.95

AIR RAID is a game where large and small airplanes fly across the screen at different altitudes. A ground based missile launcher is pointed and fired from the keyboard. Missiles may be guided after launching! Aircraft explode dramatically when hit, sometimes destroying other nearby planes! Score is tallied for each hit or miss, and the highest score is saved to be challenged by other players. Play ends when time runs out, but extra time may be earned with a high score. **AIR RAID** provides hours of fun for you, and is a super demonstration program for entertaining friends! Runs in 4K.

All software shipped postpaid with LEVEL I and LEVEL II versions on the same cassette. Add shipping for hardware items. (Calif. residents add 6% tax).

S51

*** SMALL SYSTEM SOFTWARE * P.O. BOX 366 * NEWBURY PARK, CALIF. 91320 ***

TRS-80 HARDWARE

TRS232 PRINTER INTERFACE - $39.95 (Assembled and Tested)

The **TRS232** is a self-contained software-driven output port. Cassette software and source listings for driving printers from LEVEL-II BASIC or machine language programs are furnished. Diablo printers, Teletype Model 43, TI Silent, or any RS-232 printer may be used with the TRS232. A 20-mil current loop output drives model-33 110 baud teletypes. The TRS232 is small (about 1" x 2" x 3") and installs in series with the power and cassette cables on your TRS-80 computer (all cables and connectors are furnished). A standard DB-25 connector mates with the printer cable. The TRS232 may be left in place at all times, since it does not interfere with cassette operation. THE ELECTRIC PENCIL uses the TRS232, thus both word processing and BASIC program listing and documentation are supported!

PARA-PORT: 2 1/2 PORT PARALLEL I/O BOARD - $79.95 (KIT)

Our parallel port board can be used for driving LED light displays, reading external keyboards, polling sense switches, driving parallel port printers, controlling relays for lamps, sprinklers, or any place where control of external devices is desired! The TRS-80 can now control something besides a cassette recorder! The board contains two full 8-bit input and output ports. It features 8212 input latches which automatically generate the necessary status information when new data is input. Output strobes are generated and there is a third 4-bit status port so that full handshaking protocol may be established. Requires external 5-volt power supply.

40/44-1: SINGLE-SLOT ADAPTER - $24.95 ($19.95 with PARA-PORT)

Consists of a small adapter board, 40 pin edge connector, 44 pin socket, power supply connections, support feet, and a 40 pin ribbon cable to connect to the TRS-80 expansion port. Operate any of our boards, or use any 44-pin board to do your own thing! A trade-in allowance will be offered to upgrade to our six-slot buffered mother board.

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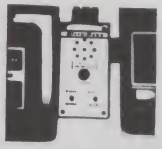
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LST-1:	**7.95**	A disassembled listing of LEVEL-1 BASIC with some comments.
SCM-1:	**4.95**	A fully detailed schematic of the TRS-80 microcomputer.
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TRS-80

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The Micro-Mega Cassette Control Unit does a lot to clean up and neaten up your whole TRS-80 installation too. As shown at the left, it's in a 2½" x5" box which snuggles between the keyboard and your recorder. There is no need to move the recorder, and there no longer are any 90 degree cable bends whipping around. It's fast, neat and convenient, - and it's a bargain!

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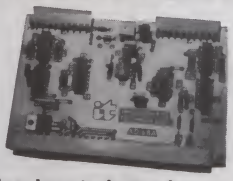
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BUSS F4

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Dear Kilobaud reader:

Buss lets you in on news of H8- and H11-compatible hardware and software from other vendors as well as providing information on new items being developed in Benton Harbor before their official announcement. It also shares the experiences of users with their computers and peripherals from Heath Co. All this can help you plan additions to your system.

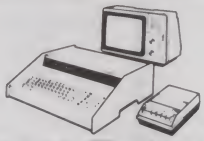
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Charles Floto

CHARLES FLOTO EDITOR

SOL-20 SOFTWARE

from ESV Computer Service



Processor Technology

DIAGNOSTICS II: Checks user RAM (addresses are keyboard selectible by operator), video RAM, SOLOS or Bootload RAM, audio interface, and personality module. Features hard-copy printout of video displays using TAB key, and selectible output ports. Cassette tape comes with SOLOS version on one side & Bootload (BOOTL) on the other for use with either cassette or Helios SOL Systems ..... $50. on cassette

DISASSEMBLER: Allows conversion of machine language programs to assembly language. Features operator selectible output ports for hard-copy printer or video display and audio cassette storage of disassembled text. Permits modification to be made for custom use or possible relocation. Symbol table may be anywhere in RAM and is assigned by the operator during initialization. Line numbers and labels are automatically assigned by the disassembler during construction of the assembly language program. Special characters will be displayed in the line number's most significant digit to flag the need to divide the machine code for 2 or more passes when the line number exceeds 9999. Tape storage (if selected) is done byte-by-byte (text) for use with assemblers other than ALS-8 or Software #1. ..... $30. on cassette

MAILBOX: A mailing list program designed to work on your Helios Disk System. Features online editing for data entry, operator may select serial or parallel drivers (included on diskette) for hard copy, pre-sorted mailing labels (by zip codes as required by postal regulations for bulk mailing), label search, modification of single line should address or name need changes, file status check to determine amount and percentage of "dead space" and number of names in file, file compression to remove data in the same size file, generate separate diskette to increase data storage, will dump files to either 2 or 4 columns on printer, and is operator selectible ..... $45. on Helios diskette

DROIDS: An action game where you play the computer. Try to escape Droids by hiding behind fences. Features static practice mode for skill development and real time attack mode with selectible difficulty factors ..... $19.50 on cassette

ALS-8 UTILITIES adds cassette I/O operations to ALS-8. Included are seven custom tape commands and five clear memory commands. Source program on cassette will assemble into 12C (hex) bytes.
EC-001 Source program on cassette tape **$15.00**

SOFTPAC #1 cassette uses Basic/5 on any Sol-20/SOLOS with 16K of RAM. Included are four games, STAR, BLACKJACK, CRAPS, and WAR.
EC-002 Basic/5 programs on cassette tape **$18.00**

BLOCKADE is an action game for two players on the same keyboard. Build a wall as you move and trap your opponent. Get sound effects through an AM radio or the Music System. Machine language program runs in 8K of RAM.
EC-003 Machine language program on cassette **$14.00**

SOL-20 DIAGNOSTIC checks user RAM, system RAM, SOLOS, keyboard, video, and cassette interface. This machine language program requires 8K of RAM.
EC-004 Machine language program on cassette **$45.00**

CALENDAR & TIME has a calendar for whatever month and year you want. Also included is a time program which displays hours, minutes, and seconds on the screen. These Basic/5 programs require 16K of RAM.
EC-005 Basic/5 programs on cassette tape **$10.00**

DIRECT REDUCTION LOAN provides amortization schedule for entire loan period or a single period of interest. Total interest paid is also calculated. 12K of RAM is required for this Basic/5 program.
EC-006 Basic/5 program on cassette tape **$10.00**

ACCOUNTS RECEIVABLE uses cassette data files to keep customer information on cassette tape. Functions include update, report, search, and enter new records. 20K of RAM and 2 cassette recorders are required to run this Extended Cassette Basic Program.
EC-007 Basic program on cassette tape **$25.00**

SMARTMOUTHED BLACKJACK uses Las Vegas rules including split hands, double down, and insurance bets. The humorous wise-cracks of the dealer keep the attention of the player for hours. This Extended Cassette Basic program requires 32K of RAM.
EC-008 Basic program on cassette tape **$19.50**

BIORHYTHM cassette produces complete plot or a simple list of critical days. Output can be directed to any pseudo port. Extended Cassette Basic version requires 24K. Basic/5 version requires 16K. Any number of days can be forecast.
EC-009 Basic/5 program on cassette tape **$19.50**
EC-010 Extended Cassette Basic program cassette **$19.50**

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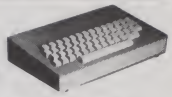
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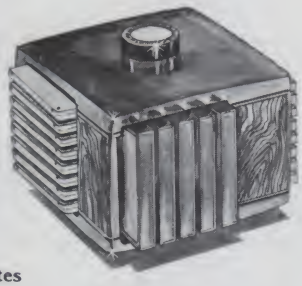
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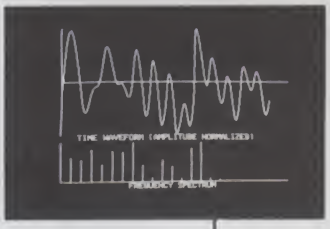
OUR VISIBLE MEMORY ADDS FUNCTION AND FUN TO YOUR 6502

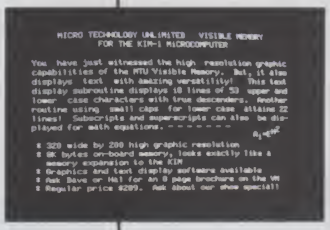
This DOT MATRIX display board doubles as an 8K MEMORY. You can use it as a display, memory expansion or both with graphic and text display software available. You get high resolution graphics with no wait states, no snow, and no processor overhead. K-1008 ASSEMBLED and TESTED $289.00, BARE BOARD $40.00 K-1008-1 GRAPHIC/TEXT UTILITY SOFTWARE LISTING $20.00.



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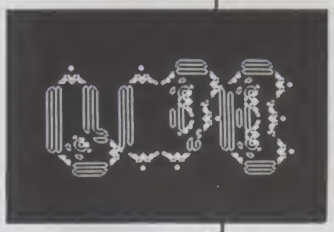
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AROUND THE INDUSTRY

(from page 7)

warehouse store in Garden Grove CA and our late-fall-opening shop in Chicago's Water Tower Place as two sites for Computer Centers within Radio Shack stores. We are also considering converting some existing Radio Shack stores to Computer Centers in order to hasten the day when we are truly nationwide with this project." Capital expenditures for the 50 centers are expected to total about $4 million.

Several executives have been named to key positions in Radio Shack's computer organization.

Ted. F. Cromer, formerly general manager of Tandy Computers and a veteran of 13 years with IBM, has been selected as director of Radio Shack Computer Centers. He will be assisted by the Radio Shack district manager in the area of each center.

Jon A. Shirley, who has been with the company since 1958 in a variety of merchandising functions, most recently with their overseas operation, has been named director of Radio Shack computer merchandising, a newly created position.

Carroll B. Ray will be director of computer applications, another new position chiefly concerned with the development and acquisition of TRS-80 software programs. Ray, who joined Tandy Corporation in 1964 and was named Radio Shack vice-president/controller in 1970, has been involved in the area of corporate development for the Radio Shack division.

According to Kornfeld, "Within each Computer Center we expect to see at least one sales manager with extensive computer experience, a technician and clerical help." He added that "several hundred new job openings have been created by the launching of the program, and in addition, Radio Shack's Fort Worth computer factory continues to expand in people and space."

CORRECTIONS

Carl A. Wall of Willowdale, Ontario Canada, writes: Loaded the program in the article "It's Here: Cook's Memory Test" (July 1978, p. 70) in my SOL-20 and it did not work. The problem was traced to the call statements in program B. These should be changed to the following to work with SOLOS version 1.3 (released 77-03-27).

Address	Op Code
C993	CD 19 C0
C997	CD E8 C3
C9A0	CD 19 C0

The following replacement lines were sent to us by the authors of "(Con)text Editor" (September 1978, p. 22) too late to incorporate into the article.

```
 710  CLOAD*L:CLOAD*F:FORI = 1TOQ:T$ = ""
 720  FORI = 1TOQ:B(F(I)) = I:NEXT:B(U) = 0:B(UN) = 0:F(0) = 0:B(0) = 0:L(0) = 0:GOTO25
 760  L(0) = U:CSAVE*L:F(0) = UN:CSAVE*F:FORI = 1TOQ:J = LEN(L$(I)):IFJ = 0THEN780
1100  K = LEN(T$):FORJ = PTOLEN(I$):IFMID$(I$,J,K)<>T$THENNEXT:R = 1:RETURN
1101  IFLEN(I$) = 0THENI = 0
1102  P = J + K:R = 0:RETURN
```

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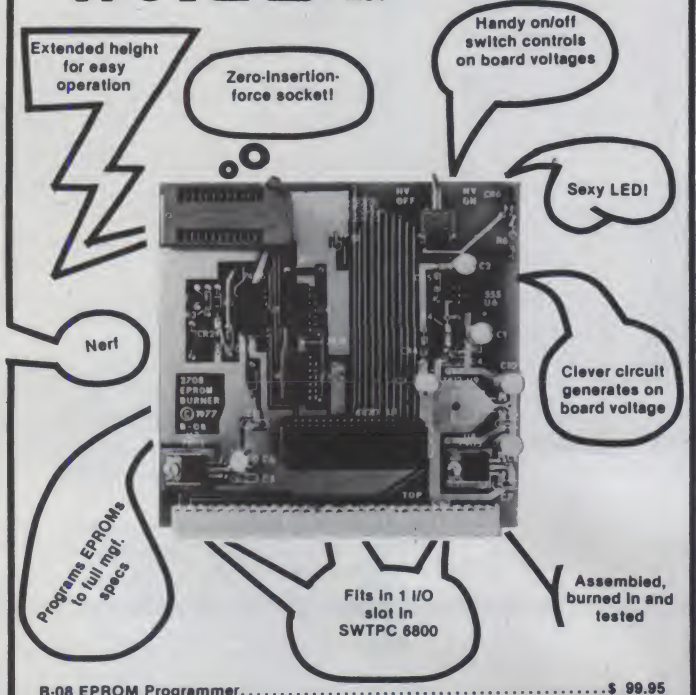
TBS INC.

The Bottom Shelf, Inc.
P.O. Box 49104
Atlanta, Georgia 30359

THE MICRO WORKS

EPROM PROGRAMMER SPEAKS FOR ITSELF!

M31



B-08 EPROM Programmer ..... **$ 99.95**
regulated + 12 v. $104.95

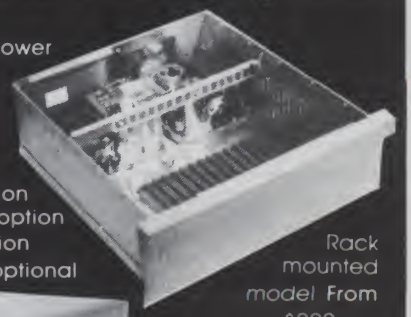
U2708 Utility in EPROM ..... **$ 29.95**
All software routines necessary to test, burn, verify and copy 2708s using the B-08 Programmer

DEPT. K, P.O. BOX 1110, DEL MAR, CA 92014 (714) 756-2687

S-100 MAINFRAME $200

S-100 MAINFRAME $200

- NOT A KIT
- 8v@15A, ±16v@3A power
- Rack mountable
- 15 slot motherboard
- Card cage
- Fan, line cord, fuse, switch, EMI filter
- Desk top version option
- 8v@30A, ±16v@10A option
- Voltage monitor option
- 100 pin connectors optional



Rack mounted model From $200



Desk top model From $235

Write or call for a copy of our detailed brochure which includes our application note BUILDING CHEAP COMPUTERS.

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We accept BankAmericard/Visa and Master Charge

SAVE

COMPUTER INTERFACES & PERIPHERALS

SAVE

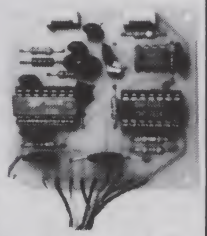
For free catalog including parts lists and schematics, send a self-addressed stamped envelope.

APPLE II SERIAL I/O INTERFACE *



Part no. 2
Baud rate is continuously adjustable from 0 to 30,000 • Plugs into any peripheral connector • Low current drain. RS-232 input and output • On board switch selectable 5 to 8 data bits, 1 or 2 stop bits, and parity or no parity either odd or even • Jumper selectable address • SOFTWARE • Input and Output routine from monitor or BASIC to teletype or other serial printer. • Program for using an Apple II for a video or an intelligent terminal. Also can output in correspondence code to interface with some selectrics. Board only — $15.00; with parts — $42.00; assembled and tested — $62.00.

MODEM *



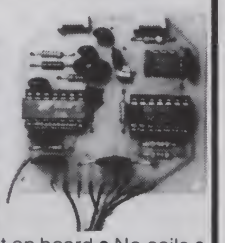
Part no. 109
• Type 103 • Full or half duplex • Works up to 300 baud • Originate or Answer • No coils, only low cost components • TTL input and output-serial • Connect 8 ohm speaker and crystal mic. directly to board • Uses XR FSK demodulator • Requires +5 volts • Board $7.60; with parts $27.50

DC POWER SUPPLY *



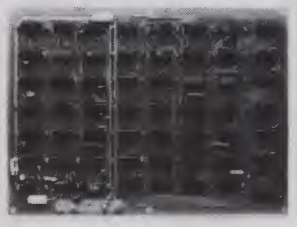
Part no. 6085
• Board supplies a regulated +5 volts at 3 amps., +12, -12, and -5 volts at 1 amp. • Power required is 8 volts AC at 3 amps., and 24 volts AC C.T. at 1.5 amps. • Board only $12.50; with parts excluding transformers $42.50

TAPE INTERFACE *



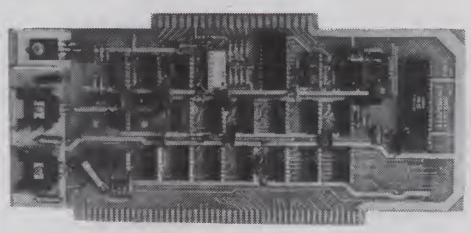
Part no. 111
• Play and record Kansas City Standard tapes • Converts a low cost tape recorder to a digital recorder • Works up to 1200 baud • Digital in and out are TTL-serial • Output of board connects to mic. in of recorder • Earphone of recorder connects to input on board • No coils • Requires +5 volts, low power drain • Board $7.60; with parts $27.50

T.V. TYPEWRITER



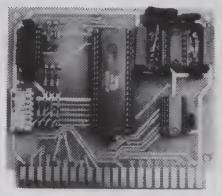
Part no. 106
• Stand alone TVT • 32 char/line, 16 lines, modifications for 64 char/line included • Parallel ASCII (TTL) input • Video output • 1K on board memory • Output for computer controlled curser • Auto scroll • Non-destructive curser • Curser inputs: up, down, left, right, home, EOL, EOS • Scroll up, down • Requires +5 volts at 1.5 amps, and -12 volts at 30 mA • All 7400, TTL chips • Char. gen. 2513 • Upper case only • Board only $39.00; with parts $145.00

TIDMA *



Part no. 112
• Tape Interface Direct Memory Access • Record and play programs without bootstrap loader (no prom) has FSK encoder/decoder for direct connections to low cost recorder at 1200 baud rate, and direct connections for inputs and outputs to a digital recorder at any baud rate. • S-100 bus compatible • Board only $35.00; with parts $110.00

UART & BAUD RATE GENERATOR *



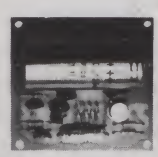
Part no. 101
• Converts serial to parallel and parallel to serial • Low cost on board baud rate generator • Baud rates: 110, 150, 300, 600, 1200, and 2400 • Low power drain +5 volts and -12 volts required • TTL compatible • All characters contain a start bit, 5 to 8 data bits, 1 or 2 stop bits, and either odd or even parity. • All connections go to a 44 pin gold plated edge connector • Board only $12.00; with parts $35.00 with connector add $3.00

8K STATIC RAM



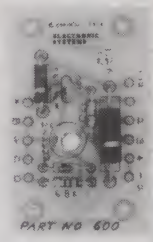
Part no. 300
• 8K Altair bus memory • Uses 2102 Static memory chips • Memory protect • Gold contacts • Wait states • On board regulator • S-100 bus compatible • Vector input option • TRI state buffered • Board only $22.50; with parts $160.00

RF MODULATOR *



Part no. 107
• Converts video to AM modulated RF, Channels 2 or 3. So powerful almost no tuning is required. On board regulated power supply makes this extremely stable. Rated very highly in Doctor Dobbs' Journal. Recommended by Apple. • Power required is 12 volts AC C.T., or +5 volts DC • Board $7.60; with parts $13.50

RS 232/TTY * INTERFACE



Part no. 600
• Converts RS-232 to 20mA current loop, and 20mA current loop to RS-232 • Two separate circuits • Requires +12 and -12 volts • Board only $4.50, with parts $7.00

RS 232/TTL * INTERFACE



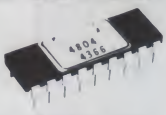
Part no. 232
• Converts TTL to RS-232, and converts RS-232 to TTL • Two separate circuits • Requires -12 and +12 volts • All connections go to a 10 pin gold plated edge connector • Board only $4.50; with parts $7.00 with connector add $2.00

ELECTRONIC SYSTEMS Dept. KB, P.O. Box 21638, San Jose, CA. USA 95151

To Order: Mention part number and description. For parts kits add "A" to part number. In USA, shipping paid for orders accompanied by check, money order, or Master Charge, BankAmericard, or VISA number, expiration date and signature. Shipping charges added to C.O.D. orders. California residents add 6.5% for tax. Outside USA add 10% for air mail postage, no C.O.D.'s. Checks and money orders must be payable in US dollars. Parts kits include sockets for all ICs, components, and circuit board. Documentation is included with all products. All items are in stock, and will be shipped the day order is received via first class mail. Prices are in US dollars. No open accounts. To eliminate tariff in Canada boxes are marked "Computer Parts." Dealer inquiries invited.
24 Hour Order Line: (408) 226-4064

* Circuits designed by John Bell

4804 STATIC, TTL IN/OUT 1024x4 N-MOS RAM



GENERAL DESCRIPTION

Part Number 4804 is a 4K semiconductor random access memory organized as 1024 4-bit words. It is fully static and needs no clock or refresh pulses. It requires a single +5 volt power supply and is fully TTL compatible on input and output lines. The 4804 is packaged in a convenient 18 pin dual-in-line package.

FEATURES

- Single +5V Power Supply
- 1Kx4 Organization
- Replaces 4 1024x1 Static RAMs
- Completely Static—No Clocks or Refresh
- 18 Pin Package
- Access/Cycle 600nsec max
- 250 mw Typical Operating Power
- Common I/O Bus
- TTL Compatible I/O
- Three State Outputs

TRUTH TABLE

$\overline{CE}$	R/$\overline{W}$	DI/DO	STATUS	MODE
H	Don't Care	High Z	Deselect	Standby
L	H	Data	Selected	READ
L	L	L	Selected	Write 0
L	L	H	Selected	Write 1

WRITE CYCLE—AC CHARACTERISTICS

PARAMETER	SYMBOL	4804 MIN	4804 MAX
Write Cycle Time	T_{WC}	600	
Address To Write Time	T_{AW}	100	
Write Pulse Width	T_{WP}	500	
Write Recovery Time	T_{WR}	0	
Data Set Up Time	T_{DW}	350	
Data Hold Time	T_{DH}	0	
Output Disable From Write or Chip Enable	T_{OTW}		150

READ CYCLE—AC CHARACTERISTICS

PARAMETER	SYMBOL	4804 MIN	4804 MAX
Read Cycle Time	T_{RC}	600	
Access Time	T_A		600
Chip Enable to Output Enable	T_{CO}		200
Data Valid After Address	T_{OH1}	150	
Previous Data Valid After Chip De-Select	T_{OH2}	25	

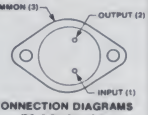
$8.95 8/$60.00 16/$100.00

TRI-TEK T1

10 AMP REGULATORS 78P05

GENERAL DESCRIPTION- The uA78P05 is a 3-terminal positive 5V hybrid regulator capable of delivering 10 Amps! This device is virtually blowout proof and contains all the protection features inherent in monolithic regulators such as internal short-ciruit current limiting and thermal-overload protection. The uA78P05 is packaged in a hermetically sealed TO-3 providing 50W at 25° C case. The hybrid consists of a monolithic control chip driving a rugged Mesa transistor. The high output current is achieved through new design technique without sacrificing the regulation characteristics of the controlling elements. The same process is employed in the construction of the 10A regulator to provide the same high reliability obtained in the uA78H05 5A regulator.

- 10 A OUTPUT CURRENT
- INTERNAL THERMAL-OVERLOAD PROTECTION
- INTERNAL SHORT-CIRCUIT CURRENT LIMIT
- LOW DROP-OUT VOLTAGE 2.2 V AT 10 A
- 50 W POWER DISSIPATION
- PIN-FOR-PIN COMPATIBLE WITH THE μA78H05, μA78H05A AND SH323
- STEEL TO-3 PACKAGE



CONNECTION DIAGRAMS TO-3 PACKAGE (TOP VIEW)

78P05SC.....$12.95
Specs..... .60

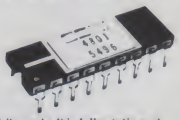
MULTI-CHANNEL 8 BIT A/D CONVERTER

Fairchilds' new 6 channel analog-to digital converter has a lot going for it. Full scale correction capabilities, ratiometric conversion and wide input dynamic range.

Micro-processor compatible, it combines the multiplexer, decoder and sample-and -hold functions with converter to save board space and eliminate external parts. It provides 8 bit, +½ LSB conversion in 300 uSec featuring auto-zero and dynamic range all the way to ground.

UA9708 in 16 pin plastic DIP.....$7.951

4801 STATIC, TTL IN/OUT 4096x1 N-MOS RAM



GENERAL DESCRIPTION

Part Number 4801 is a 4K semiconductor random access memory organized as 4096 1-bit words. It is fully static and needs no clock or refresh pulses. It requires a single +5 volt power supply and is fully TTL compatible on input and output lines. The 4801 is packaged in a convenient 18 pin dual-in-line package.

FEATURES

- Single +5V Power Supply
- 4Kx1 Organization
- Replaces 4 1024x1 Static RAMs
- Completely Static—No Clocks or Refresh
- 18 Pin Package
- Access/Cycle Times 600 nsec max
- 250 mw Typical Operating Power
- Separate Data In and Data Out
- TTL Compatible I/O
- Three State Outputs
- Data Bus Compatible I/O Function

TRUTH TABLE

$\overline{CE}$	R/$\overline{W}$	DI	DO	STATUS	MODE
H	Don't Care	Don't Care	High Z	Deselect	Standby
L	H	Don't Care	Data	Selected	READ
L	L	L	High Z	Selected	Write 0
L	L	H	High Z	Selected	Write 1

WRITE CYCLE—AC CHARACTERISTICS

PARAMETER	SYMBOL	4801 MIN	4801 MAX
Write Cycle Time	T_{WC}	600	
Address To Write Time	T_{AW}	100	
Write Pulse Switch	T_{WP}	500	
Write Recovery Time	T_{WR}	0	
Data Set Up Time	T_{DW}	350	
Data Hold Time	T_{DH}	0	
Output Disable From Write or Chip Enable	T_{OTW}		150

READ CYCLE—AC CHARACTERISTICS

PARAMETER	SYMBOL	4801 MIN	4801 MAX
Read Cycle Time	T_{RC}	600	
Access Time	T_A		600
Chip Enable to Output Enable	T_{CO}		200
Data Valid After Address	T_{OH1}	150	
Previous Data Valid After Chip De-Select	T_{OH2}	25	

$8.95 8/$60.00 16/$100.00

INTEGRATED TONE RECEIVER MK5102(N)-5

FEATURES

- ☐ Detects all 16 standard DTMF digits
- ☐ Requires minimum external parts count for minimum system cost
- ☐ Uses inexpensive 3.579545 MHz crystal for reference
- ☐ Digital counter detection with period averaging insures minimum false response
- ☐ 16-pin package for high system density
- ☐ Single supply 5 Volts ± 10%
- ☐ Output in either 4-bit binary code or dual 2-bit row/column code
- ☐ Latched outputs

DESCRIPTION

The MK5102 is a monolithic integrated circuit fabricated using the complementary-symmetry MOS (CMOS) process. Using an inexpensive 3.579545 MHz television colorburst crystal for reference, the MK5102 detects and decodes the 8 standard DTMF frequencies used in telephone dialing. The requirement of only a single supply and its construction in a 16-pin package make the MK5102 ideal for applications requiring minimum size and external parts count.

DETECTION FREQUENCY

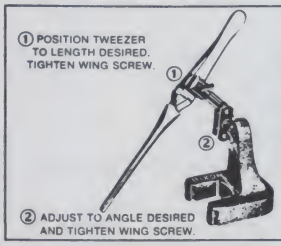
Low Group f_o	High Group f_o
Row 1 = 697 Hz	Column 1 = 1209 Hz
Row 2 = 770 Hz	Column 2 = 1336 Hz
Row 3 = 852 Hz	Column 3 = 1477 Hz
Row 4 = 941 Hz	Column 4 = 1633 Hz

MK5102N-5.....$34.95
Specs..... .50
600 Ohm to 600 Ohm C.T. transformer.....$1.95
Colorburst crystal for above.....$1.75

DIXON

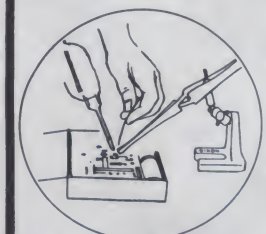
THE THIRD HAND

- This versatile tool has proven its worth through generations of use by professional craftsmen.
- The Third Hand holds work in any position freeing both hands to perform other vital functions.

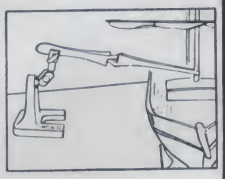


CROSSLOCK TWEEZER
Dixon #H-500

- Tweezer exerts 1½ lb. tension on blunt ends
- Double ball joint allows positioning of tweezer at any angle
- Heavy iron base may be held in vise or clamped to bench



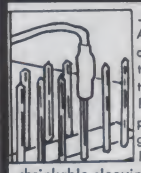
• FREES HANDS



Dixon Third Hand...$7.95

VOLTAGE REGULATORS

7805-06-08-12-15-24 TO220	95¢ 5/$4.50
78L05A-12-15 4% 100 mA TO-92 Plastic	50¢
78H05KC 5V 5A TO-3	8.45
78H12KC 12V 5A TO-3	9.15
78H15KC 15V 5A TO-3	9.15
Lm317K 1.5A *Adjustable* TO-3	4.99
Lm317T 1.5A *Adjustable* TO-220	3.99
Lm317MP .5A *Adjustable* TO-202	13.95
TL430C Adjustable Zener-*Think About It*	1.50
TL497C Switching Reg. & Inductor	9.50
RCA CA 3085 100 mA *Adjustable*	.60
Signetics 2504TA 1024 bit S.R. memory (1404A)...	.50
MCM 6571P Character Generator	9.95
MCM6571AP Character Generator	9.95
MC14409P Telephone Rotary Pulser	10.98
MC14419P Touch Pad Converter for 14409	4.25
MC14411P Baud Rate Generator	11.98
MC14412VP CMOS Modem Chip	16.95
MM57109N Number Cruncher Micro	18.95
74C915 7 Segment to BCD Converter	2.99
74C922 16 Key Keyboard Encoder	6.35
74C923 20 key Keyboard Encoder	6.45
74C925 4 Decade Counter w/latches	12.00
74C926 4 Decade Counter w/carry	12.00
74C935-1 3½ Digit DVM CMOS Chip	16.98



Jumper Kits for .025 Square Posts.. All material for making jumpers for quick circuit changes and prototyping. Use for breadboarding, trouble shooting, field modifications. Fits standard IC socket wire/wrap posts. Excellent wiping actian an gold plated bax contacts.

Kit contain 10 bax contacts, heat shrinkable sleeving, and 5 feet of wire plus instructian sheet.

JCK-5101....(5 double jumpers)$2.75, 4 kits/$10.00

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Phoenix, Arizona 85021
(602) 995-9352

- Please give street address for UPS shipping when possible.
- C.O.D. NO parcel post C.O.D. UPS C.O.D. Add 85¢ to order.
- Any correspondence not connected with your order, please use separate sheet and include SASE for reply.
- Orders less than $10 ($15 foreign) please add $1 handling.
- Prices are subject to change without notice.
- Any refunds will be by check, not credit vouchers.
- Terms, Check, money order, credit card. Net 30 days to rated firms, schools and government agencies.
- If we should be temporarily out of stock on an item, it will be placed on back order. If we cannot ship in 30 days, you will be notified of the expected shipping date and furnished with a postage paid card with which to cancel your order if desired.
- We pay surface shipping only in USA, Canada and Mexico.
- For premium shipping (first class, special handling, etc.) add extra, Excell will be refunded.
- Foreign orders (except Canada and Mexico) estimate and add shipping. Excess will be refunded.

Charge card telephone orders ($20 min.) will be accepted 9-5:30 P.M. except weekends. Telephone 995-9352. No collect calls please.

DIODES/ZENERS

1N914	100v	10mA	.05
1N4005	600v	1A	.08
1N4007	1000v	1A	.15
1N4148	75v	10mA	.05
1N4733	5.1v	1 W Zener	.25
1N753A	6.2v	500 mW Zener	.25
1N758A	10v	"	.25
1N759A	12v	"	.25
1N5243	13v	"	.25
1N5244B	14v	"	.25
1N5245B	15v	"	.25

SOCKETS/BRIDGES

8-pin	pcb	.20	ww	.35
14-pin	pcb	.20	ww	.40
16-pin	pcb	.20	ww	.40
18-pin	pcb	.25	ww	.75
22-pin	pcb	.35	ww	.95
24-pin	pcb	.35	ww	.95
28-pin	pcb	.45	ww	1.25
40-pin	pcb	.50	ww	1.25
Molex pins .01		To-3 Sockets		.25
2 Amp Bridge		100-prv		.95
25 Amp Bridge		200-prv		1.95

TRANSISTORS, LEDS, etc.

2N2222	NPN (2N2222 Plastic .10)	.15
2N2907	PNP	.15
2N3906	PNP (Plastic - Unmarked)	.10
2N3904	NPN (Plastic - Unmarked)	.10
2N3054	NPN	.35
2N3055	NPN 15A 60v	.50
T1P125	PNP Darlington	.95
LED Green, Red, Clear, Yellow		.15
D.L.747	7 seg 5/8" High com-anode	1.95
MAN72	7 seg com-anode (Red)	1.25
MAN3610	7 seg com-anode (Orange)	1.25
MAN82A	7 seg com-anode (Yellow)	1.25
MAN74A	7 seg com-cathode (Red)	1.50
FND359	7 seg com-cathode (Red)	1.25

C MOS

4000	.15
4001	.15
4002	.20
4004	3.95
4006	.95
4007	.20
4008	.75
4009	.35
4010	.35
4011	.20
4012	.20
4013	.40
4014	.75
4015	.75
4016	.35
4017	.75
4018	.75
4019	.35
4020	.85
4021	.75
4022	.75
4023	.20
4024	.75
4025	.20
4026	1.95
4027	.35
4028	.75
4030	.35
4033	1.50
4034	2.45
4035	.75
4040	.75
4041	.69
4042	.65
4043	.50
4044	.65
4046	1.25
4049	.45
4050	.45
4066	.55
4069/74C04	.25
4071	.25
4081	.30
4082	.30
MC 14409	14.50
MC 14419	4.85
4511	.95
74C151	1.90

— T T L —

7400	.10	7473	.25	74176	.85	74H72	.35
7401	.15	7474	.30	74180	.55	74H101	.75
7402	.15	7475	.35	74181	2.25	74H103	.55
7403	.15	7476	.40	74182	.75	74H106	.95
7404	.10	7480	.55	74190	1.25		
7405	.25	7481	.75	74191	.95	74L00	.25
7406	.25	7483	.75	74192	.75	74L02	.20
7407	.55	7485	.55	74193	.85	74L03	.25
7408	.15	7486	.25	74194	.95	74L04	.30
7409	.15	7489	1.05	74195	.95	74L10	.20
7410	.15	7490	.45	74196	.95	74L20	.35
7411	.25	7491	.70	74197	.95	74L30	.45
7412	.25	7492	.45	74198	1.45	74L47	1.95
7413	.25	7493	.35	74221	1.00	74L51	.45
7414	.75	7494	.75	74367	.75	74L55	.65
7416	.25	7495	.60			74L72	.45
7417	.40	7496	.80	75108A	.35	74L73	.40
7420	.15	74100	1.15	75491	.50	74L74	.45
7426	.25	74107	.25	75492	.50	74L75	.55
7427	.25	74121	.35			74L93	.55
7430	.15	74122	.55			74L123	.85
7432	.20	74123	.35	74H00	.15		
7437	.20	74125	.45	74H01	.20	74S00	.35
7438	.20	74126	.35	74H04	.20	74S02	.35
7440	.20	74132	.75	74H05	.20	74S03	.25
7441	1.15	74141	.90	74H08	.35	74S04	.25
7442	.45	74150	.85	74H10	.35	74S05	.35
7443	.45	74151	.65	74H11	.25	74S08	.35
7444	.45	74153	.75	74H15	.45	74S10	.35
7445	.65	74154	.95	74H20	.25	74S11	.35
7446	.70	74156	.70	74H21	.25	74S20	.25
7447	.70	74157	.65	74H22	.40	74S40	.20
7448	.50	74161	.55	74H30	.20	74S50	.20
7450	.25	74163	.85	74H40	.25	74S51	.25
7451	.25	74164	.60	74H50	.25	74S64	.15
7453	.20	74165	1.10	74H51	.25	74S74	.35
7454	.25	74166	1.25	74H52	.15	74S112	.60
7460	.40	74175	.80	74H53J	.25	74S114	.65
7470	.45			74H55	.20		
7472	.40						

74S133	.40
74S140	.55
74S151	.30
74S153	.35
74S157	.75
74S158	.30
74S194	1.05
74S257 (8123)	1.05
74LS00	.20
74LS01	.20
74LS02	.20
74LS04	.20
74LS05	.25
74LS08	.25
74LS09	.25
74LS10	.25
74LS11	.25
74LS20	.20
74LS21	.25
74LS22	.25
74LS32	.25
74LS37	.25
74LS38	.35
74LS40	.30
74LS42	.65
74LS51	.35
74LS74	.35
74LS86	.35
74LS90	.55
74LS93	.55
74LS107	.40
74LS123	1.00
74LS151	.75
74LS153	.75
74LS157	.75
74LS164	1.00
74LS193	.95
74LS367	.75
74LS368	.65

LINEARS, REGULATORS, etc.

MCT2	.95
8038	3.95
LM201	.75
LM301	.45
LM308 (Mini)	.95
LM309H	.65
LM309K (340K-5)	.85
LM310	.85
LM311D (Mini)	.75
LM318 (Mini)	1.75
LM320K5(7905)	1.65
LM320K12	1.65
LM320T5	1.65
LM320T12	1.65
LM320T15	1.65
LM324N	1.25
LM339	.75
7805 (340T5)	.95
LM340T12	.95
LM340T15	.95
LM340T18	.95
LM340T24	.95
LM340K12	1.25
LM340K15	1.25
LM340K18	1.25
LM340K24	1.25
78L05	.75
78L12	.75
78L15	.75
78M05	.75
LM373	2.95
LM380 (8-14 PIN)	.95
LM709 (8, 14 PIN)	.25
LM711	.45
LM723	.40
LM725N	2.50
LM739	1.50
LM741 (8-14)	.25
LM747	1.10
LM1307	1.25
LM1458	.65
LM3900	.50
LM75451	.65
NE555	.35
NE556	.85
NE565	.95
NE566	1.25
NE567	.95

9000 SERIES

9301	.85	95H03	1.10
9309	.35	9601	.20
9322	.65	9602	.45

MICRO'S, RAMS, CPU'S, E-PROMS

74S188	3.00	8214	8.95
1702A	4.50	8224	3.25
MM5314	3.00	8228	6.00
MM5316	3.50	8251	8.50
2102-1	1.45	8255	8.50
2102L-1	1.75	8T13	1.50
2114	9.50	8T23	1.50
TR1602B	3.95	8T24	2.00
TMS 4044-5	9.95	8T97	1.00
		2107B-4	4.95
8080	8.95	2708	9.50
8212	2.95	Z80 PIO	8.50

INTEGRATED CIRCUITS UNLIMITED

19

7889 Clairemont Mesa Boulevard, San Diego, California 92111
(714) 278-4394 *(Calif. Res.)*

All orders shipped prepaid — No minimum
Open accounts invited — COD orders accepted

Discounts available at OEM Quantities — California Residents add 6% Sales Tax
All IC's Prime/Guaranteed. All orders shipped same day received.

SPECIAL DISCOUNTS

Total Order	Deduct
$35 - $99	10%
$100 - $300	15%
$301 - $1000	20%

24 Hour Toll Free Phone 1-800-854-2211 — **American Express / BankAmericard / Visa / MasterCharge**

SALE S·100 BUS EDGE CONNECTORS SALE

NLS MS-215 DUAL TRACE MINISCOPE $435.00

NLS MS-215 DUAL TRACE MINISCOPE $435.00



NLS

1¢ SALE

LM3A 3 dig 1% DC $134.00
LM3.5A 3½ dig .5% DC $158.50
LM40A 4 dig .1% DC..... $209.00
LM4A 4 dig .03% DC $250.00

- Rechargeable batteries and charger included
- Measures DC Volts, AC Volts, Ohms and Current
- Automatic polarity, decimal and overload indication

- Rechargeable batteries and charger
- Measures DC Volts, AC Volts, Ohms and Current
- Automatic polarity, decimal and overload indication
- No zero adjustment and no full-scale ohms adjust
- Battery-operated — NiCad batteries; also AC line operation.
- Large LED display for easy reading without interpolation
- Size: 1.9"H x 2.7"W x 4"D
- Parts & labor guaranteed 1 year
- Tilt stand option ..... $ 3.50
- Leather case $20.00

Purchase any of the LM series Meters and buy the LEATHER CASE for 1¢



NLS

$318.

MS-15 MINISCOPE With Rechargeable Batteries & Charger Unit

- 15 megahertz bandwidth.
- External and Internal trigger.
- Time base — .1 microsec. to 0.5 Sec/div - 21 settings ±3%.
- Battery or line operation.
- Automatic & line sync modes.
- Power consumption < 15 watts.
- Vertical Gain — .01 to 50 V/div - 12 settings ±3%.
- Viewing area 1.1" x 1.35"
- Case size 2.7"H x 6.4"W x 7.5"D, 3 pounds.
- Parts & Labor guaranteed 1 year
- 10 to 1, 10 meg probe ..... $ 27.
- Leather carrying case ..... $ 45.

PROBE 1¢

PROBE 1¢ with the purchase of SCOPE and the MENTION of this MAGAZINE

NLS

● MS-215 Dual Trace Version of MS-15 **$435.**

SALE S-100 BUS EDGE CONNECTORS SALE



S100-WWG 50/100 Cont 125 ctrs 3 LEVEL WIRE WRAP .025" sq. posts on 250 spaced rows. GOLD plated
1-4 $4.00 | 5-9 $3.75 | 10-24 $3.50

S100-STG 50/100 Cont 125 ctrs DIP SOLDER TAIL on 250 spaced rows for VECTOR and MASI motherboards GOLD plated
1-4 $4.00 | 5-9 $3.75 | 10-24 $3.50

RG81G 50/100 Cont 125 ctrs DIP SOLDER TAIL on 140 spaced rows for ALTAIR motherboards GOLD plated $5.00

R681-3 50/100 Cont 125 ctrs PIERCED SOLDER EYELET tails GOLD $7.35

Other Popular Edge Connectors

R644-G 22/44 Cont 156 ctrs PIERCED SOLDER EYELES tails GOLD plated.
1-4 $3.00 | 5-9 $2.75 | 10-24 $2.50

R644-3 22/44 Cont 156 ctrs WIRE WRAP tails GOLD $4.71

ATTN: OEM'S and Dealers, many other connectors available call or quotation.

3 LEVEL GOLD WIRE WRAP SOCKETS



	1-24	25-49	50-99	100-249	250-999	1K-5K
8 pin*	.41	.38	.35	.31	.27	.23
14 pin*	.39	.38	.36	.32	.29	.27
16 pin*	.43	.42	.39	.35	.32	.30
18 pin	.63	.58	.54	.47	.42	.36
20 pin	.80	.75	.70	.63	.58	.53
22 pin*	.90	.85	.80	.70	.61	.57
24 pin	.90	.84	.78	.68	.63	.58
28 pin	1.10	1.00	.90	.84	.76	.71
40 pin	1.50	1.40	1.30	1.20	1.04	.89

Sockets purchased in multiples of 50 per type may be combined for best price.

All sockets are GOLD 3 level closed entry * End and side stacable. 2 level, Solder Tail, Low Profile, Tin Sockets and Dip Plugs available. CALL FOR QUOTATION

- Kit includes 12 tantalum capacitors for +5, +12, —12 buses and insulated mounting spacers
- Wiring side shown. Component side bare epoxy glass with white markings for component locations
- G10 epoxy glass board with 2 ounce copper, solder plated and .038 diameter holes for leads
- Solder mask with solder windows on etched circuits to avoid accidental short circuits
- Mounts 11 receptacles with 100 contacts (2 rows) on .125 centers with .250 row spacing. Vector part number R681-2, or mounts 10 receptacles plus interconnections to smaller mother board for expansion
- Includes etched circuits and instructions for option of active pull-up, or floating terminations
- Large buses +5V and GND (10 AMPS), ± 12V or 16V (7 AMPS). Current ratings are per MIL-STD 275 with 10°C rise
- Fits in Vector-pak enclosures
- Fits in IMSAI 8080 microcomputer as expander board

8803 MOTHER BOARD FOR S100 BUS MICRO-COMPUTERS

Vector



Price: $29.50

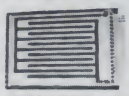


Vector

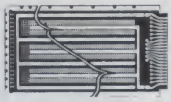
Plugboards

8800V
Universal Microcomputer/processor plugboard, use with S-100 bus. Complete with heat sink & hardware 5.3" x 10" x 1/16
1-4 $19.95 | 5-9 $17.95 | 10-24 $15.96

8801-1
Same as 8800V except plain; less power buses & heat sink
1-4 $14.95 | 5-9 $13.46 | 10-24 $11.96



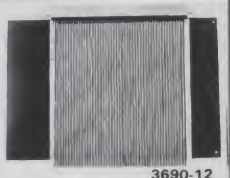
3682 9.6" x 4.5" **$10.97**
3682-2 6.5" x 4.5" **$9.81**
Hi-Density Dual-In-Line Plugboard for Wire Wrap with Power & Grd. Bus Epoxy Glass 1/16" 44 pin con. spaced .156



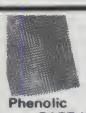
3677 9.6" x 4.5" **$10.90**
3677-2 6.5" x 4.5" **$9.74**
Gen. Purpose D.I.P. Boards with Bus Pattern for Solder or Wire Wrap. Epoxy Glass 1/16" 44 pin con. spaced .156



3662 6.5" x 4.5" **$7.65**
3662-2 9.6" x 4.5" **$11.45**
P pattern plugboards for IC's Epoxy Glass 1/16" 44 pin con. spaced .156



3690-12 CARD EXTENDER
Card Extender has 100 contacts-50 per side on .125 centers-Attached connector-is compatible with S-100 Bus Systems..... $25.00
3690 6.5" 22/44 pin .158 ctrs. Extenders $12.00



1/16 Vector BOARD
.042 dia holes on 0.1 spacing for IC's

Phenolic

PART NO.	SIZE	PRICE 1 - 9	10 - 19
64P44XXXP	4.5x6.5"	$1.49	1.34
169P44XXXP	4.5x17"	$3.51	3.16

Epoxy Glass

64P44	4.5x6.5"	$1.70	1.53
84P44	4.5x8.5"	$2.10	1.89
169P44	4.5x17"	$4.30	3.87
169P84	8.5x17"	$7.65	6.89

SLIT-N-WRAP
Wraps insulated wire on .025" square posts
FOUR TIMES FASTER than regular manual wrap post tools



$24.50



P180 with two 100' spools of 28 ga. wire
P180-4T includes charger, wire **$75.00**

Vector

NO PRE-STRIPPING
NO PRE-CUTTING*
SPOOL-FED WIRE*
*The spooled wire passes through the tool past a slitting edge next to the wrap post. A narrow longitudinal cut is made in the insulation where it presses the square post corner. The bared copper is indented by the sharp edge. (7 turns = 28 contacts)
Insulation is cut where wrapped but not between terminal posts, when set straight out of the tool

"Daisy-chain" runs. Reliable and easy to use. Manual or power operation

SLIT-N-WRAP WIRE NO. 28 GAGE INSULATED WIRE, 100' SPOOLS
W28-2 A Pkg. 3 Green W28-2 C Pkg. 3 Clear
W28-2 B Pkg. 3 Red W28-2 D Pkg. 3 Blue
Chocolate Brown
2 choices please

$2.25 Package

2708
8K 450 ns
EPROM
FACTORY PRIME
$ 9.00 EA.
25 + Call For Price

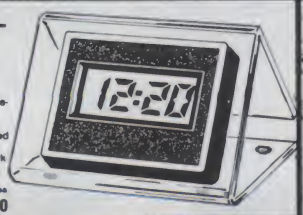
14 & 16 PIN GOLD 3 LEVEL WIRE WRAP SOCKETS



14 - G3 100 for **$30.00**
16-G3 100 for **$30.00**
50 of each for **$32.00**
Sockets are End & Side stackable, closed entry

LIQUID CRYSTAL DIGITAL CLOCK-CALENDAR

- For Auto, Home, Office
- Small in size (2x2½x½)
- Push button for seconds release for date.
- Clocks mount anywhere with either 3M double-sided tape or VELCRO, included.
- 2 MODELS AVAILABLE:
  LCD-101, portable model runs on self-contained batteries for better than a year.
  LCD-102, runs on 12 Volt system and is back lighted.
- LCD-101 or LCD-102 your choice. **$34.95 ea.**
- Clear desk stand for **$2.00**



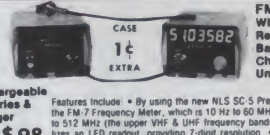
LEDU MG 10A List $72.



Perfectly balanced, fluorescent lighting with precision magnifier lens. For profi, techn'l & hobbist. Has die cast protective shade, inst. start 3 diopter lens 42" reach.

$44.95
with T 8 fluorescent lamp (required) **$44.95**
colors: Gray or Black
Chocolate Brown
2 choices please

$44.95 SPECIAL

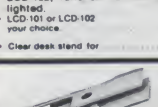


SC-5 With Rechargeable Batteries & Charger Unit $98

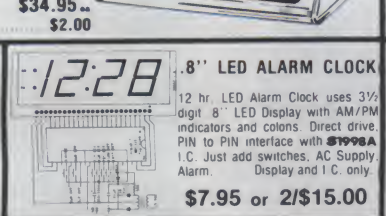
NLS

FM-7 With Rechargeable Batteries & Charger Unit $215

Features include: • By using the new NLS SC-5 Prescaler, the range of the FM-7 Frequency Meter, which is 10 Hz to 60 MHz, may be extended to 512 MHz (the upper VHF & UHF frequency bands). • The FM-7 utilizes an LED readout, providing 7-digit resolution. • The FM-7 can be calibrated to an accuracy of 0.00001%. • The SC-5 is accurate to one part per million. • Each unit has 30 millivolts sensitivity, is battery powered and has a charger unit included. • Dimensions of each are 1.9" H x 2.7" W x 3.9" D. • The units may be obtained separately or as a "Frequency Duo." • Parts & Labor guaranteed 1 year.
Tilt stand option ..... $ 3.50
Leather case $20.00



MICRO-KLIP
for .042 dia. holes
(all boards on this page)
T42-1 pkg. 100 $ 1.50
T42-1 pkg. 1000 ..... $11.00
P-149 hand installing tool ..... $ 2.03



.8" LED ALARM CLOCK

12 hr. LED Alarm Clock uses 3½ digit .8" LED Display with AM/PM indicators and colons. Direct drive. PIN to PIN interface with **81998A** I.C. Just add switches, AC Supply, Alarm Display and I.C. only.

$7.95 or 2/$15.00

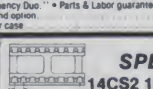
1

Price Breakthrough!



$17.50
MA1003 CAR CLOCK
Bright Green Fluorescent Display Crystal Time Base Assembled, just add switches and 12 VDC.

SPECIAL



14CS2 100 for $14.00
16CS2 100 for $16.00
14 pin CS2 10 for $2.00
16 pin CS2 8 for $2.00

These low cost DIP sockets will accept both standard width plugs and chips.
For use with chips, the sockets offer a low profile height of only .125" above the board. These sockets are end stackable.

Vector

WRAP POST
for .042 dia. holes
(all boards on this page)
T-44 pkg. 100 .. $ 2.28
T-44 pkg. 1000 ..... $14.00
A-13 hand installing tool ..... $ 2.80

PRIORITY ONE ELECTRONICS © P21

10031C Woodley Ave. Sepulveda CA. 91343

Terms: VISA, MC, BAC, check, Money Order, C.O.D., U.S. Funds Only. CA residents add 6% sales tax. Minimum order $10.00. Orders less than $75.00 include 10% shipping and handling; excess refunded. Just in case please include your phone no. **"Sorry, no over the counter sales"**

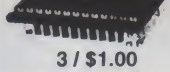
GOOD THRU NOVEMBER 1978

Send for our latest brochure.

phone orders welcome (213) 893-8202

OEM and Institutional inquiries invited.

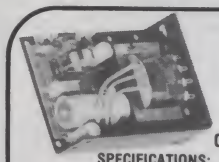
24 PIN DIP PLUGS WITH COVERS



3 / $1.00
40 / $10.00

SALE S·100 BUS EDGE CONNECTORS SALE

ELPAC POWER SUPPLIES



Completely Assembled

SPECIFICATIONS:
105-125/210-250 Vac, 47-440 Hz Input:

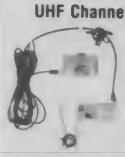
Line Regulation	±0.1%
Load Regulation	±0.1%no-load to rated-load
Output Ripple and Noise	±0.1%p-p,dc to 10 MHz
Input/Output Isolation	100 megohm dc, 900 Vac
Short Circuit Current	35% rated current

PART NO.	RATINGS WATTS	VOLTS	AMPS	PRICE
SOLV15-5*	15	5	3	$39.95
SOLV15-12*	18	12	1.5	39.95
SOLV30-5	30	5	6	59.95
SOLV30-12	48	12	4	59.95
OVP1	over voltage protection for SOLV30-5,-12			9.95

*SOLV15-5, 12 includes OVP installed

SUP 'R' MOD II

UHF Channel 33 TV Interface Unit Kit



- Wide Band B/W or Color System
- Converts TV to Video Display for home computers, CCTV camera, Apple II, works with Cromeco Dazzler, SOL-20, IRS-80, Challenger, etc.
- MOD II is pretuned to Channel 33 (UHF).
- Includes coaxial cable and antenna transformer.

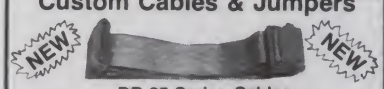
MOD II $29.95 Kit

CRYSTALS

THESE FREQUENCIES ONLY

PART NO.	FREQUENCY	CASE	PRICE
CY1A	1.000MHz	HC33	5.95
CY1.84	1.8432MHz	HC33	5.95
CY2A	2.000MHz	HC33	5.95
CY2.01	2.010MHz	HC33	1.95
CY2.50	2.500MHz	HC33	4.95
CY3.27	3.2768MHz	HC33	4.95
CY3.57	3.579545MHz	HC33	4.95
CY3A	4.000MHz	HC18	4.95
CY4.91	4.916MHz	HC18	4.95
CY7A	5.000MHz	HC18	4.95
CY5.18	5.185MHz	HC18	4.95
CY6.14	6.144MHz	HC18	4.95
CY6.40	6.400MHz	HC18	4.95
CY6.55	6.5536MHz	HC18	4.95
CY12A	10.000MHz	HC18	4.95
CY14A	14.31818MHz	HC18	4.95
CY19A	18.000MHz	HC18	4.95
CY18.43	18.432MHz	HC18	4.95
CY22A	20.000MHz	HC18	4.95
CY30A	32.000MHz	HC18	4.95

Custom Cables & Jumpers



DB 25 Series Cables

Part No.	Cable Length	Connectors	Price
DB25P-4-P	4 Ft.	2-DP25P	$15.95 ea.
DB25P-4-S	4 Ft.	1-DP25P/1-25S	$16.95 ea.
DB25S-4-S	4 ft.	2-DP25S	$17.95 ea.

Dipped Jumpers Plugs

DJ14-1	1 ft.	1-14 Pin	$1.59 ea.
DJ16-1	1 ft.	1-16 Pin	1.79 ea.
DJ24-1	1 ft.	1-24 Pin	2.79 ea.
DJ14-1-14	1 ft.	2-14 Pin	2.79 ea.
DJ16-1-16	1 ft.	2-16 Pin	3.19 ea.
DJ24-1-16	1 ft.	2-24 Pin	4.95 ea.

For Custom Cables & Jumpers, See JAMECO 1979 Catalog for Pricing

1/16 VECTOR BOARD

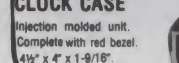
	0.1" Hole Spacing Part No	P-Pattern L	W	Price 1-9	10 up
PHENOLIC	64P44 062XXXP	4.50	6.50	1.72	1.54
	169P44 062XXXP	4.50	17.00	3.69	3.32
EPOXY	64P44 062WE	4.50	6.50	2.07	1.86
GLASS	84P44 062WE	4.50	8.50	2.56	2.31
	169P44 062WE	4.50	17.00	5.04	4.53
	169P84 062WE	8.50	17.00	9.23	8.26
EPOXY GLASS COPPER CLAD	169P44 062WEC1	4.50	17.00	6.80	6.12

CONNECTORS

25 Pin-D Subminiature

DB25P(as pictured)	PLUG	$2.95
DB25S	SOCKET	3.50
DB51226-1	Cable Cover for DB25 P or S	1.75

MOLEX CONNECTOR PINS



M-530-1 $1.95/100 pins (minimum order) $16.00/1000 pins

Pre-packaged in strips

INSTRUMENT/ CLOCK CASE

Injection molded unit. Complete with red bezel. 4½" x 4" x 1-9/16".



$3.49

MICROPROCESSOR COMPONENTS

CDP 1802	CPU	$19.95
P8085	CPU	19.95
8080A	CPU	9.95
8212	8-Bit Input/Output	3.25
8214	Priority Interrupt Control	5.95
8216	Bi-Directional Bus Driver	3.49
8224	Clock Generator/Driver	3.95
8228	System Controller/BusDriver	5.95
8251	Prog. Comm. Interface	7.95
8253	Prog. Interval Timer	14.95
8255	Prog. Periph. Interface	9.95
8257	Prog. DMA Control	19.95

RAM'S

1101	256 x 1	Static	$ 1.49
1103	1024 x 1	Dynamic	.99
2101(8101)	256 x 4	Static	3.95
2102	1024 x 1	Static	1.75
2107/5280	4096 x 1	Dynamic	4.95
2111(8111)	256 x 4	Static	3.95
2112	256 x 4	Static	4.95
2114	1024 x 4	Static 450ns	9.95
2114L	1024 x 4	Static 450ns Low Power	10.95
2114-3	1024 x 4	Static 300ns	10.95
2114L-3	1024 x 4	Static 300ns Low Power	11.95
7489	16 x 4	Static	1.75
8599	16 x 4	Static	3.49
21L02	1024 x 1	Static	1.95
74S200	256 x 1	Static	4.95
93421	256 x 1	Static	2.95
MM5262	2K x 1	Dynamic	3/1.00
MK4027 (UPD414)	4K	DYNAMIC 16 PIN	4.95
MK4116 (UPD416)	16K	DYNAMIC 16 PIN	14.95
TMS4044-45NL	4K	STATIC	14.95

ROM'S

2513(2140)	Character Generator (upper case)	$ 9.95
2513(3021)	Character Generator (lower case)	9.95
2516	Character Generator	10.95
MM5230N	2048 Bit Read Only Memory	1.95

USER MANUALS

1802M	CDP1802 Manual	$ 7.50
Z80M	Z80 Manual	7.50
2650M	2650 Manual	5.00

Z80(780C)	CPU	$19.95
Z80A(708-1)	CPU	24.95
2650	MPU	26.50
MC6800	MPU	14.95
MC6810API	128 x 8 Static Ram	5.95
MC6821	Periph.Interface Adapter(6820)	7.49
MC6830L8	1024 x 8 Bit ROM(68A30)	14.95
MC6850	Asychronous Comm Adapter	7.95
MC6852	Syn. Serial Data Adapter	9.95
MC6880	(MC8T26) Quad Tri State Bus Trans.	2.25
MC6802	MPU w/Clock & Ram	24.95

PROMS

1702A	2048 x 1	Famous	$ 5.95
5203	2048 x 1	Famous	14.95
82S23	32 x 8	Open C	3.95
82S115	4096 x 1	Bipolar	19.95
82S123	32 x 8	Tristate	3.95
74S287	1024 x 1	Static	2.95
TMS2532	32K	EPROM	99.95
2708	8K	EPROM	10.95
2716 T.I.	16K	EPROM	29.95
2716 Intel (2516 T.I.)	16K	EPROM	49.95
6301-1	1024 x 1	Tri-State Bipolar	3.49
6330-1	256 x 1	Open C Bipolar	2.95

SHIFT REGISTERS

MM5016H	500/512 Bit Dynamic	.89
2504T	1024 Dynamic	3.95
2518	Hex 32 Bit Static	4.95
2522	Dual 132 Bit Static	2.95
2524	512 Dynamic	.99
2525	1024 Dynamic	2.95
2527	Dual 256 Bit Static	2.95
2528	Dual 250 Static	4.00
2529	Dual 240 Bit Static	4.00
2532	Quad 80 Bit Static	2.95
2533	1024 Static	2.95
3341	Fifo	6.95
74LS670	4 x 4 Register	1.95

UART'S

AY-5-1013	30K BAUD	$ 5.95

SPECIAL REQUESTED ITEMS

TELEPHONE KEYBOARD CHIPS

AY-5-9100	$14.95
AY-5-9200	14.95
AY-5-9500	4.95
AY-5-2376	14.95
HD0165	7.95
74C922	9.95

ICM CHIPS

ICM7045	$24.95
ICM7205	19.95
ICM7207	7.50
ICM7208	19.95
ICM7209	6.95

TV GAME CHIP SET
AY-3-8500-1 Chip and 2.010 MHz Crystal **$7.95**

NMOS READ ONLY MEMORIES

MCM6571	$13.50
MCM6574	13.50
MCM6575	13.50

MISCELLANEOUS

11C90	$19.95	MK40240	$17.50
MC3061P	11.95	DS0026CH	3.75
MC1408L7	4.95	TL308	10.20
MC1408L8	5.75	95H90	11.95
LD110/111	$25.00/set		
MC4016(74416)	7.50		
4N33	3.95		



The Sinclair PDM35. A personal digital multimeter for only $59.95

Now everyone can afford to own a digital multimeter

A digital multimeter used to mean an expensive, bulky piece of equipment.

The Sinclair PDM35 changes that. It's got all the functions and features you want in a digital multimeter, yet they're neatly packaged in a rugged but light pocket-size case, ready to go anywhere.

The Sinclair PDM35 is supplied completely assembled with test leads and prods, protective wallet and Operator's Manual.

The Sinclair PDM35 is tailor-made for anyone who needs to make rapid measurements. Development engineers, field service engineers, lab technicians, computer specialists, radio and electronic hobbyists will find it ideal.

Technical specification

DC Volts (4 ranges)
Range 1 mV to 1000 V
Accuracy of reading 1.0% ± 1 count
Note 10 MΩ input impedance

AC Volts (40 Hz-5 kHz)
Range 1 V to 500 V
Accuracy of reading 1.0% ± 2 counts

DC Current (5 ranges)
Range 1 nA to 200 mA
Accuracy of reading 1.0% ± 1 count
Note Max. resolution 0.1 nA

Resistance (5 ranges)
Range 1Ω to 20 MΩ
Accuracy of reading 1.5% ± 1 count
Also provides 5 junction-test ranges

Dimensions: 6 in x 3 in x 1½ in

Weight: 6½ oz

Power supply: 9 V battery or Sinclair AC adapter (battery not incl.)

Sockets: Standard 4 mm for resilient plugs

Options: AC adapter for 117 V 60 Hz power De-luxe padded carrying wallet

PART NO.	DESCRIPTION	PRICE
PDM35	Digital Multimeter (Completely Assembled)	$59.95
PDM-AC	117volt AC Adapter	6.95
PDM-DP	Deluxe padded carrying case	6.95

BK PRECISION 3½-Digit Portable DMM



- Overload Protected
- 3" high LED Display
- Battery or AC operation
- Auto Zeroing
- 1mv, 1Va, 0.1 ohm resolution
- Overange reading
- 10 meg input impedence
- DC Accuracy 1%+ typical

Ranges: DC Voltage - 0-1000V
AC Voltage 0-1000V
Freq. Response 50-400 HZ
DC/AC Current: 0-100mA
Resistance 0-10 meg ohm
Size 6.4" x 4.4" x 2"

Model 2800 $99.95

Comes with test leads, operating manual and spare fuse

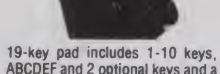
Accessories:

AC Adapter BC-28	$9.00
Rechargeable Batteries BP-26	20.00
Carrying Case LC-28	7.50

CSC 100 MHz 8-Digit Counter

- 20 Hz-100 MHz Range
- 8" LED Display
- Crystal-controlled timebase
- Fully Automatic
- Portable — completely self-contained
- Size — 1.75" x 7.38" x 5.63"
- Four power souces, i.e. batteries, 110 or 220V with charger 12V with auto lighter adapter and external 7.2-10V power supply

MAX-100 $134.95



ACCESSORIES FOR MAX 100:

Mobile Charger Eliminator use power from car battery — Model 100 — CLA $3.95

Charger/Eliminator use 110 V AC — Model 100 — CAI $9.95

KEYBOARDS

63-Key Unencoded | Hexadecimal Key Pad Unencoded



This is a 63-key, terminal keyboard newly manufactured by a large computer manufacturer. It is unencoded with SPST keys, unattached to any kind of PC board. A very solid molded plastic 13 x 4" base suits most application. IN STOCK **$29.95/each**



19-key pad includes 1-10 keys, ABCDEF and 2 optional keys and a shift key. **$10.95/each**

$5.00 Minimum Order — U.S. Funds Only
California Residents — Add 6% Sales Tax

Spec Sheets — 25¢
1979 A Catalog Available—Send 41¢ stamp

NEW 1979 Catalog

Jameco ELECTRONICS

a division of JAMES ELECTRONICS of California

PHONE ORDERS WELCOME (415) 592-8097

MAIL ORDER ELECTRONICS — WORLDWIDE
1021 HOWARD AVENUE, SAN CARLOS, CA 94070
Advertised Prices Good Thru November

The Incredible "Pennywhistle 103"



$139.95 Kit Only

The Pennywhistle 103 is capable of recording data to and from audio tape without critical speed requirements for the recorder and it is able to communicate directly with another modem and terminal for telephone "hamming" and communications. In addition, it is free of critical adjustments and is built with non-precision, readily available parts.

Data Transmission Method	Frequency-Shift Keying, full-duplex (half-duplex selectable)
Maximum Data Rate	300 Baud.
Data Format	Asynchronous Serial (return to mark level required between each character).
Receive Channel Frequencies	2025 Hz for space, 2225 Hz for mark
Transmit Channel Frequencies	Switch selectable. Low (normal) = 1070 space, 1270 mark. High = 025 space, 2225 mark.
Receive Sensitivity	46 dbm accoustically coupled.
Transmit Level	-15 dbm nominal. Adjustable from -6 dbm to -20 dbm
Receive Frequency Tolerance	Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz.
Digital Data Interface	EIA RS-232C or 20 mA current loop (receiver is optoisolated and non-polar).
Power Requirements	120 VAC, single phase, 10 Watts.
Physical	All components mount on a single 5" by 9" printed circuit board. All components included.

Requires a VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align.

The Original the 3rd Hand

$9.95 each



- Leaves two hands free for working
- Clamps on edge of bench, table or work bench
- Position board on angle or flat position for soldering or clipping
- Sturdy, aluminum construction for hobbyist, manufacturer or school rooms

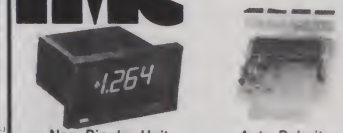
TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K. Kit comes complete with:
* 8 each UPD416 (16K Dynamic Rams)
* Documentation for conversion

TRS-16K $115.00

Special Offer - Order both your TRS-16K and the Sup'R' MOD II Interface kit together (retail value $144.95) **for only $139.95**

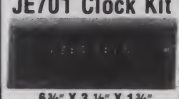
IMC 3½ DIGIT DPM KIT



- New Bipolar Unit
- Auto Zeroing
- .5" LED
- Auto Polarity
- Low Power
- Single IC Unit

Model KB500 DPM Kit $49.00
Model KB503 5V Power Kit $17.50

JE701 Clock Kit



6¾" X 3 ⅛" X 1¾"

$19.95 per Kit

- 6 Digit, .300 Height Common Cathode Display
- Uses MM5314 Clock Chip
- Push Button Switches for setting Hours, Minutes & Hold.
- Easily Viewable to 20 Feet
- Simulated Walnut Case
- 115 VAC Operation
- 12 or 24 Hour Format
- Includes all Components & Case

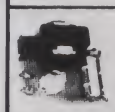
JE803 PROBE



The Logic Probe is a unit which is for the most part indespensible in trouble shooting logic families TTL DTL RTL CMOS. It derives the power it needs to operate directly off of the circuit under test drawing a scant 10 mA max. It uses a MAN3 readout to indicate any of the following states by these symbols: (H) - (LOW) - 0 (PULSE) - P. The Probe can detect high frequency pulses to 45 MHz. It can't be used at MOS levels or circuit damage will result.

$9.95 Per Kit

printed circuit board



T_2L 5V 0.5A Supply

This is standard TTL power supply using the well known LM309K regulator IC to provide a solid 0.5 AMP of current at 5 volts. We try to make things easy for you by providing everything you need in one package including the hardware for only.

JE225 $9.95 Per Kit

CSC PROTO BOARDS

PROTO BOARD 6
$15.95
(6" long X 4" wide)



PB100 - 4.5" x 6"	$ 19.95
PB101 - 5.8" x 4.5"	22.95
PB102 - 7" x 4.5"	26.95
PB103 - 9" x 6"	44.95
PB104 - 9.5" x 8"	54.95
PB203 - 9.75 x 6½ x 2¾	75.00
PB203A - 9.75 x 6½ x 2¾ (includes power supply)	124.95



PROTO CLIPS

14 PIN	$4.50
16 PIN	4.75
24 PIN	8.50
40 PIN	13.75

7400 TTL

SN7400N	.16	SN7470N	.29
SN7401N	.18	SN7472N	.29
SN7402N	.18	SN7473N	.35
SN7403N	.18	SN7474N	.35
SN7404N	.18	SN7475N	.49
SN7405N	.20	SN7476N	.35
SN7406N	.29	SN7478N	5.00
SN7407N	.29	SN7480N	.50
SN7408N	.20	SN7482N	.99
SN7409N	.20	SN7483N	.59
SN7410N	.18	SN7485N	.79
SN7411N	.25	SN7486N	.35
SN7412N	.25	SN7489N	1.75
SN7413N	.40	SN7490N	.45
SN7414N	.70	SN7491N	.59
SN7416N	.25	SN7492N	.43
SN7417N	.25	SN7493N	.43
SN7420N	.20	SN7494N	.65
SN7421N	.29	SN7495N	.65
SN7422N	.39	SN7496N	.65
SN7423N	.25	SN74100N	.89
SN7425N	.29	SN74107N	.35
SN7426N	.29	SN74109N	.59
SN7427N	.25	SN74116N	1.95
SN7429N	.39	SN74121N	.35
SN7430N	.20	SN74122N	.39
SN7432N	.25	SN74123N	.49
SN7437N	.25	SN74125N	.49
SN7438N	.25	SN74126N	.49
SN7439N	.25	SN74132N	.75
SN7440N	.20	SN74136N	.75
SN7441N	.89	SN74141N	.79
SN7442N	.49	SN74142N	2.95
SN7443N	.75	SN74143N	2.95
SN7444N	.75	SN74144N	2.95
SN7445N	.75	SN74145N	.79
SN7446N	.69	SN74147N	1.95
SN7447N	.59	SN74148N	1.29
SN7448N	.79	SN74150N	.89
SN7450N	.20	SN74151N	.59
SN7451N	.20	SN74152N	.59
SN7453N	.20	SN74153N	.59
SN7454N	.20	SN74154N	.99
SN7459A	.25	SN74155N	.79
SN7460N	.20	SN74156N	.79
		SN74157N	.65

SN74160N	.69	SN74174N	.89
SN74161N	.89	SN74175N	.79
SN74162N	1.95	SN74176N	.79
SN74163N	.89	SN74177N	.79
SN74164N	.89	SN74179N	1.95
SN74165N	.89	SN74180N	.79
SN74166N	1.25	SN74181N	1.95
SN74167N	1.95	SN74182N	.89
SN74170N	1.59	SN74184N	1.95
SN74172N	6.00	SN74185N	1.95
SN74173N	1.25	SN74186N	9.95
SN74174N	.89	SN74188N	3.95

20% Discount 100 pcs combined order 25% -1000 pcs combined order.

C/MOS

CD4000	.23	CD4028	.89	CD4070	.55
CD4001	.23	CD4029	1.19	CD4071	.23
CD4002	.23	CD4030	.49	CD4072	.49
CD4006	1.19	CD4035	.99	CD4081	.23
CD4007	.25	CD4040	1.19	CD4082	.23
CD4009	.49	CD4041	1.25	CD4093	.99
CD4010	.49	CD4042	.99	CD4098	2.49
CD4011	.23	CD4043	.89	MC14409	14.95
CD4012	.25	CD4044	.89	MC14410	14.95
CD4013	.39	CD4046	1.79	MC14411	14.95
CD4014	1.39	CD4047	2.50	MC14419	4.95
CD4015	1.19	CD4048	1.35	MC14433	19.95
CD4016	.49	CD4049	.49	MC14506	.75
CD4017	1.19	CD4050	.49	MC14507	.99
CD4018	.99	CD4051	1.19	MC14562	14.50
CD4019	.49	CD4052	1.19	MC14583	3.50
CD4020	1.19	CD4053	1.19	CD4508	3.95
CD4021	1.39	CD4054	2.95	CD4510	1.39
CD4022	1.19	CD4055	2.95	CD4511	1.29
CD4023	.23	CD4059	9.95	CD4515	2.95
CD4024	.79	CD4060	1.49	CD4518	1.29
CD4025	.23	CD4066	.79	CD4520	1.29
CD4026	2.25	CD4068	.39	CD4566	2.25
CD4027	.69	CD4069	.45		

74C00

74C00	.39	74C85	3.95	74C163	3.00
74C02	.55	74C90	3.00	74C164	3.25
74C04	.75	74C93	2.00	74C173	2.60
74C08	.75	74C95	2.00	74C192	3.49
74C10	.65	74C107	1.25	74C193	2.75
74C14	3.00	74C147	2.90	74C195	2.75
74C20	.65	74C151	2.90	74C922	9.95
74C30	.65	74C154	3.00	74C923	8.95
74C42	2.15	74C157	2.15	74C925	14.95
74C48	4.75	74C160	3.25	74C926	11.95
74C73	1.50	74C161	3.25	80C95	1.50
74C74	1.15			80C97	1.50

LINEAR

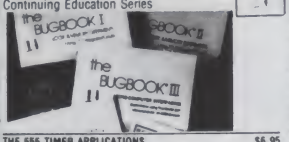
78MG	1.75				
LM300H	.80	LM340T-6	1.25	LM741CN/H	.35
LM301CN/H	.35	LM340T-8	1.25	LM741-14N	.39
LM302H	.75	LM340T-12	1.25	LM747N/H	.79
LM304H	1.00	LM340T-15	1.25	LM748N/H	.39
LM305H	.60	LM340T-18	1.25	LM1303N	.90
LM307CN/H	.35	LM340T-24	1.25	LM1304N	1.19
LM308CN/H	1.00	LM350N	1.00	LM1305N	1.40
LM309H	1.10	LM351CN	.65	LM1307N	.85
LM309K	1.25	LM370N	1.15	LM1310N	2.95
LM310CN	1.15	LM373N	3.25	LM1351N	1.65
LM311N/H	.90	LM377N	4.00	LM1414N	1.75
LM312H	2.00	LM380N	1.25	LM1458CN/H	.59
LM317K	8.50	LM380CN	.99	MC1488N	1.95
LM318CN/H	1.50	LM381N	1.79	MC1489N	1.95
LM319N	1.30	LM382N	1.79	LM1496N	.95
LM320K-5	1.35	NE501N	8.00	LM1556V	1.75
LM320K-5.2	1.35	NE510A	6.00	MC1741SCP	3.00
LM320K-12	1.35	NE529A	4.95	LM2901N	2.95
LM320K-15	1.35	NE531H/V	3.95	LM3053N	1.50
LM320K-18	1.35	NE536T	6.00	LM3065N	.69
LM320K-24	1.35	NE540L	6.00	LM3900N(3401)	.49
LM320T-5	1.25	NE544N	4.95	LM3905N	.89
LM320T-5.2	1.25	NE550N	1.30	LM3909N	1.25
LM320T-8	1.25	NE555V	.39	MC5558V	.59
LM320T-12	1.25	NE556N	.99	LM7525N	.90
LM320T-15	1.25	NE560B	5.00	LM7534N	.75
LM320T-18	1.25	NE561B	5.00	8038B	4.95
LM320T-24	1.25	NE562B	5.00	LM75450N	.50
LM323K-5	5.95	NE565N/H	1.25	75451CN	.39
LM324N	1.80	NE566CN	1.75	75452CN	.39
LM339N	.99	NE567V/H	.99	75453CN	.39
LM340K-5	1.35	NE570N	10.50	75454CN	.39
LM340K-6	1.35	LM703CN/H	.45	75491CN	.79
LM340K-8	1.35	LM709N/H	.29	75492CN	.89
LM340K-12	1.35	LM710N	.79	75494CN	.89
LM340K-15	1.35	LM711N	.39	RC4136	1.25
LM340K-18	1.35	LM723N/H	.55	RC4151	5.95
LM340K-24	1.35	LM733N	1.00	RC4194	5.95
LM340T-5	1.25	LM739N	1.19	RC4195	4.49

74LS00 TTL

74LS00	.23	74LS51	.23	74LS139	.69
74LS01	.23	74LS54	.23	74LS151	.69
74LS02	.23	74LS55	.23	74LS155	.69
74LS03	.23	74LS73	.35	74LS157	.69
74LS04	.29	74LS74	.35	74LS160	.89
74LS05	.29	74LS75	.49	74LS161	.89
74LS08	.23	74LS76	.35	74LS162	.89
74LS09	.29	74LS83	.75	74LS163	.89
74LS10	.23	74LS85	.99	74LS174	2.49
74LS13	.49	74LS86	.35	74LS175	.89
74LS14	.99	74LS90	.49	74LS181	2.49
74LS15	.29	74LS92	.59	74LS190	.89
74LS20	.23	74LS93	.59	74LS191	.89
74LS21	.29	74LS95	.79	74LS192	.89
74LS22	.29	74LS96	.89	74LS193	.89
74LS26	.29	74LS107	.35	74LS195	.89
74LS27	.29	74LS109	.35	74LS253	.79
74LS28	.29	74LS112	.35	74LS257	.69
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XC209	Yellow	4/$1	XC526	Green	4/$1	XC556	Green	4/$1	XC111	Yellow	4/$1
200" dia			XC526	Yellow	4/$1	XC556	Yellow	4/$1	XC111	Clear	4/$1
XC22	Red	5/$1	XC526	Clear	4/$1	XC556	Clear	7/$1	085" dia		
XC22	Green	4/$1							MV50	Red	6 $1
XC22	Yellow	4/$1							170" dia		
									MV10	Red	4/$1
									INFRA-RED LED		
									¼ x ¼ x 1 16		
									Flat		5/$1.00

DISPLAY LEDS

TYPE	POLARITY	HT	PRICE	TYPE	POLARITY	HT	PRICE
MAN 1	Common Anode-red	.270	2.95	MAN 6730	Common Anode-red ± 1	.560	.99
MAN 2	5 x 7 Dot Matrix-red	.300	4.95	MAN 6740	Common Cathode-red-D.D.	.560	.99
MAN 3	Common Cathode-red	.125	.25	MAN 6750	Common Cathode-red ± 1	.560	.99
MAN 4	Common Cathode-red	.187	1.95	MAN 8760	Common Anode-red	.560	.99
MAN 52	Common Anode-green	.300	1.25	MAN 6780	Common Cathode-red	.560	.99
MAN 72	Common Anode-red	.300	.99	DL701	Common Anode-red ± 1	.300	.99
MAN 74	Common Cathode-red	.300	1.25	DL704	Common Cathode-red	.300	.99
MAN 82	Common Anode-yellow	.300	.99	DL707	Common Anode-red	.300	.99
MAN 84	Common Cathode-yellow	.300	.99	DL741	Common Anode-red	.600	1.25
MAN 3620	Common Anode-orange	.300	.99	DL746	Common Anode-red ± 1	.630	1.49
MAN 3630	Common Anode-orange ± 1	.300	.99	DL747	Common Anode-red	.600	1.49
MAN 3640	Common Cathode-orange	.300	.99	DL749	Common Cathode-red ± 1	.630	1.49
MAN 4610	Common Anode-orange	.300	.99	DL750	Common Cathode-red	.600	1.49
MAN 4640	Common Cathode-orange	.400	.99	DL338	Common Cathode-red	.110	.35
MAN 4710	Common Anode-red ± 1	.400	.99	FND70	Common Cathode	.250	.69
MAN 4730	Common Anode-red	.400	.99	FND359	Common Anode	.350	.75
MAN 4740	Common Cathode-red	.400	.99	FND503	Common Cathode (FND500)	.500	.99
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MAN 6610	Common Anode-orange-D.D.	.560	.99	5082-7730	Common Anode-red	.300	1.30
MAN 6630	Common Anode-orange	.560	.99	HDSP-3400	Common Anode red	.800	2.10
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CA3046	1.30	CA3130	1.39
CA3059	3.25	CA3140	1.25
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18 pin LP	.29	.28	.27
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40 pin SG	1.75	1.59	1.45
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		180 OHM	220 OHM	270 OHM	330 OHM	390 OHM	
ASST. 3	5 ea	470 OHM	560 OHM	680 OHM	820 OHM	1K	1/4 WATT 5% 50 PCS
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		8.2K	10K	12K	15K	18K	
ASST. 5	5 ea	22K	27K	33K	39K	47K	1/4 WATT 5% 50 PCS
		56K	68K	82K	100K	120K	
ASST. 6	5 ea	150K	180K	220K	270K	330K	1/4 WATT 5% 50 PCS
		390K	470K	560K	680K	820K	
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1N751A	5.1	400m	4/1.00	1N4006	800 PIV	1 AMP	10/1.00
1N752	5.6	400m	4/1.00	1N4007	1000 PIV	1 AMP	10/1.00
1N753	6.2	400m	4/1.00	1N3600	50	200m	6/1.00
1N754	6.8	400m	4/1.00	1N4148	75	10m	15/1.00
1N959	8.2	400m	4/1.00	1N4154	35	10m	12/1.00
1N965B	15	400m	4/1.00	1N4305	75	25m	20/1.00
1N5232	5.6	500m	28	1N4734	5.6	1w	28
1N5234	6.2	500m	28	1N4735	6.2	1w	28
1N5235	6.8	500m	28	1N4736	6.8	1w	28
1N5236	7.5	500m	28	1N4738	8.2	1w	28
1N456	25	40m	6/1.00	1N4742	12	1w	28
1N458	150	7m	6/1.00	1N4744	15	1w	28
1N485A	180	10m	5/1.00	1N1183	50 PIV	35 AMP	1.60
1N4001	50 PIV	1 AMP	12/1.00	1N1184	100 PIV	35 AMP	1.70
1N4002	100 PIV	1 AMP	12/1.00	1N1185	150 PIV	35 AMP	1.70
1N4003	200 PIV	1 AMP	12/1.00	1N1186	200 PIV	35 AMP	1.80
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TIS97	6/1.00	2N3392	5/1.00	2N4013	3/1.00
TIS98	6/1.00	2N3398	5/1.00	2N4123	6/1.00
TIS133	5/1.00	PN3567	3/1.00	PN4249	4/1.00
TIS135	5/1.00	PN3568	4/1.00	PN4250	4/1.00
40409	1.75	PN3569	4/1.00	2N4400	4/1.00
40410	1.75	MPS3638A	5/1.00	2N4401	4/1.00
40673	1.75	MPS3702	5/1.00	2N4402	4/1.00
2N918	4/1.00	2N3704	5/1.00	2N4403	4/1.00
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MPS2369	5/1.00	2N3707	5/1.00	PN5129	5/1.00
2N2484	4/1.00	2N3711	5/1.00	PN5134	5/1.00
2N2906	4/1.00	2N3724A	65	PN5138	5/1.00
2N2907	5/1.00	2N3725A	1.00	PN5139	5/1.00
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MJE2955	1.25	2N3823	1.00	2N5449	3/1.00
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47 pf	05	04	03	.01μF	05	04	035
100 pf	05	04	03	.022μF	06	05	04
220 pf	05	04	03	.047μF	06	05	04
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15/35V	28	23	17	2.2/25V	31	27	22
22/35V	28	23	17	3.3/25V	31	27	22
33/35V	28	23	17	4.7/25V	32	28	23
47/35V	28	23	17	6.8/25V	36	31	25
68/35V	28	23	17	10/25V	40	35	29
1.0/35V	28	23	17	15/25V	63	50	40

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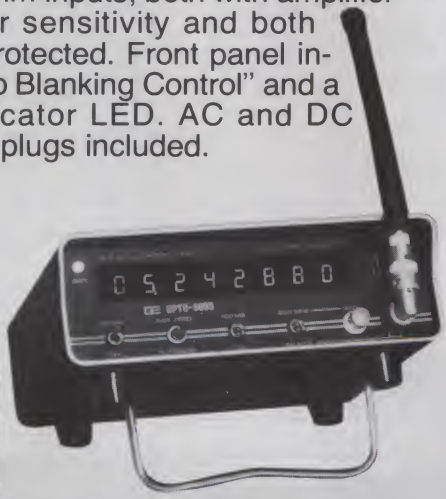
	Axial Lead				Radial Lead		
47/50V	15	13	10	47/25V	15	13	10
1.0/50V	16	14	11	47/50V	16	14	11
3.3/50V	14	12	09	1.0/16V	15	13	10
4.7/25V	15	13	10	1.0/25V	16	14	11
10/25V	15	13	10	1.0/50V	16	14	11
10/50V	16	14	12	4.7/16V	15	13	10
22/25V	17	15	12	4.7/25V	15	13	10
22/50V	24	20	18	4.7/50V	16	14	11
47/25V	19	17	15	10/16V	14	12	09
47/50V	25	21	19	10/25V	15	13	10
100/25V	24	20	18	10/50V	16	14	12
100/50V	35	30	28	47/50V	24	21	19
220/25V	32	28	25	100/16V	19	15	14
220/50V	45	41	38	100/25V	24	20	18
470/25V	33	29	27	100/50V	35	30	28
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OPTO-8000.1



This new instrument has taken a giant step in front of the multitude of counters now available. The Opto-8000.1 boasts a combination of features and specifications not found in units costing several times its price. Accuracy of ±0.1 PPM or better — *Guaranteed* — with a factory-adjusted, sealed TCXO (Temperature Compensated Xtal Oscillator). **Even kits require no adjustment for guaranteed accuracy!** Built-in, selectable-step attenuator, rugged and attractive, black anodized aluminum case (.090″ thick aluminum) with tilt bail. 50 Ohm and 1 Megohm inputs, both with amplifier circuits for super sensitivity and both diode/overload protected. Front panel includes "Lead Zero Blanking Control" and a gate period indicator LED. AC and DC power cords with plugs included.



SPECIFICATIONS:
Time Base—TCXO ±0.1 PPM GUARANTEED!
Frequency Range—10 Hz to 600 MHz
Resolution—1 Hz to 60 MHz; 10 Hz to 600 MHz
Decimal Point—Automatic
All IC's socketed (kits and factory-wired)
Display—8 digit LED
Gate Times—1 second and 1/10 second
Selectable Input Attenuation—X1, X10, X100
Input Connectors Type —BNC
Approximate Size—3″h x 7½″w x 6½″d
Approximate Weight—2½ pounds
Cabinet—black anodized aluminum (.090″ thickness)
Input Power—9-15 VDC, 115 VAC 50/60 Hz
or internal batteries

OPTO-8000.1 Factory Wired	**$299.95**
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STATIC RAMS

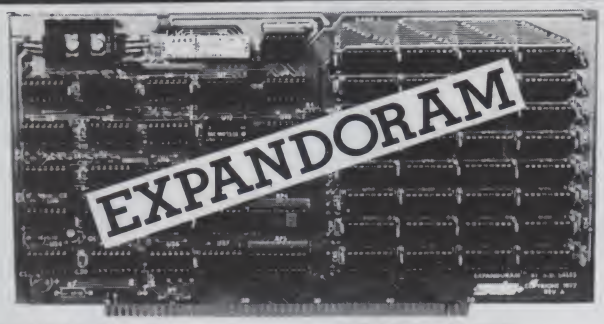
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Dynamic RAM's, can be expanded in 8K increments up to 32K.

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apple II computer

One of the best "Total Package" home and business computers on the market. "Basic" in ROM, Color Graphics, Floating Point Basic Package, etc.

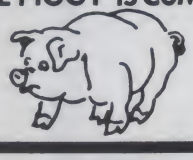
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4116 (16K x 1, 300ns) MEMORY EXPANSION KIT
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with provisions for ONBOARD 2708 and POWER ON JUMP

2 MHz

Kit	$135.00
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S-100 Compatible 6800 MPU
1K x 8 RAM, PROM expandable to 10K.
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Includes SA801R disk drive, 10" x 10" x 16" cabinet, power supply, data cable, fan, AC line filter.

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JADE 8K

Kit JG8K (450ns)	$125.95
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Bare Board without parts	$25.00

16K -Uses 2114's (lo power)

Assm & Tested RAM 16 (250ns)	$375.00
Assm. & Tested 16B (450ns)	$325.00
Mem-2 Kit (250ns)	$285.00

16K Static with memory management

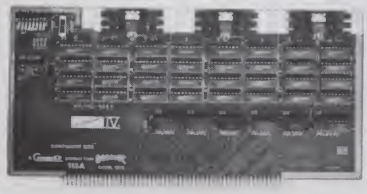
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Seals 32K

Assm. & Tested JG32 (250ns)	$795.00
Assm. & Tested JG32B (450ns)	$725.00
Kit JG32K (250ns)	$575.00

$279 = 16K

of **static** S-100 memory



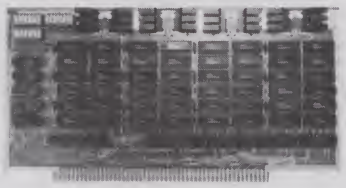
Our Econoram IV™ "unkit" comes with sockets and bypass caps pre-soldered into place for easy assembly. Plugs into ***any*** S-100 buss machine. Features under 2000 mA current, complete buffering, fully static operation, and our enviable reputation for reliability under all operating conditions.

Assembled and tested, **$314**; qualified under the CSC program*, **$414**.

$445 = 24K

of **static** S-100 memory

Econoram VII™ is an "unkit" that has sockets and bypass caps pre-soldered into place. This full feature memory is configured as two 4K and two 8K blocks for maximum flexibility, boasts current consumption under 2000 mA, and follows our design policy of fully static operation with complete buffering.

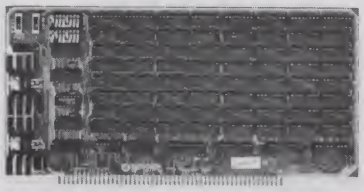


Assembled and tested, **$485**; qualified under the CSC program*, **$605**.

*(Certified Systems Components boards are assembled, tested, serial numbered, burned in for 200 hours, and guaranteed to run at 4 MHz over the full temp range. *We exchange board if failure occurs within 1 year of invoice date.)*

$135 = 8K

of **static** S-100 memory



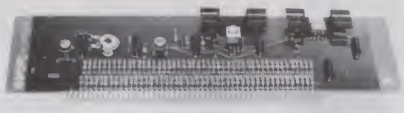
Econoram II™ is our biggest selling kit to date, thanks to the cost-effectiveness it brings to the S-100 buss. Features low current consumption, high speed, full buffering, and the same performance that has made Econoram one of the best selling peripherals in the business.

Assembled: **$155**. Quantity kit price: **3/$375**.

ALL OF THE ABOVE ARE AVAILABLE FROM STOCK. Coming soon: 32K boards for the S-100 buss, the Intel/National 80/10 and 80/20, and the Digital Group . . . plus a dual UART S-100 I/O board and our new family of S-100 Econorams. Watch this space, or inquire about price and availability.

ACTIVE TERMINATOR

$29.50 (kit)



Active termination draws much less power than passive termination, and minimizes the glitches, noise problems, crosstalk, ringing, and other gremlins that can occur with unterminated busses. Plugs into any S-100 computer. Many have copied our technique; few can match our low price.

ATTENTION — RADIO SHACK TRS-80 AND HEATH H8 OWNERS:

MEMORY PRICES ARE COMING DOWN!!

Our TRS-80 Conversion Kit chip set is now only $159 (3 kits for $450). It not only upgrades your mainframe from 4K to 16K, but can also populate the memory expansion module with extra memory. Works with APPLE computers too. We include full instructions for the TRS-80 conversion, and back up our parts with a **1 year warranty.**

Heath H8 owners are recognizing that our **12K Econoram VI™,** designed specifically for the H8 buss, offers a superior memory value at **$235. Now you can buy two of our 12K boards on special for $399** (price good through cover month of this magazine). These are "unkits" with sockets and bypass caps pre-soldered in place. Need we say more?

MOTHERBOARDS



11 slots, with active termination circuitry, heavy power/ground traces, and all edge connectors: **$90** in "unkit" form (edge connectors are pre-soldered in place, making assembly a cinch). Need more slots? Our 18 slot motherboard "unkit" includes all the above along with 18 edge connectors for **$124**.

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8 reed relays respond to an 8 bit word (relays can also drive Mullen 500 Watt AC control modules for power applications); 8 opto-isolators receive outside world signals for handshaking or further control purposes. Applications include audio, time lapse photography, robots; one user even devised an automatic cat feeder. At our new low price, you can afford to let your imagination run wild.

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EXPANDABLE EPROM BOARD

16K OR 32K EPROM $49.95 W/OUT EPROM

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KIT FEATURES:

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3. Selectable Unit States
4. On Board Regulation Provided
5. All Sockets Provided W/Board

WE CAN SUPPLY 450As 2708's AT $11.95 WHEN PURCHASED WITH BOARD.

4K LOW POWER RAM KIT

The Whole Works - $79.95

Full Buffered - on board regulated - reduced power consumption utilizing low power 21L02-1 500ns RAMS - Sockets provided for all IC's. Quality plated through PC board.



*Add $10.00 for 250ns RAM operation

EXPANDORAM

THE ULTIMATE RAM BOARD

32K FOR $475.00



32K MODEL	
8K	$151.00
16K	259.00
24K	367.00
32K	475.00

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16K	$281.00
32K	519.00
48K	757.00
64K	995.00

THE 32K VERSION USES THE MOSTEK MK4115 RAM AND HAS 8K BOUNDARIES AND PROTECTION & UTILIZES DIP SWITCHES. P. C. BOARD COMES WITH SOCKETS FOR 32K OPERATION

BUY A S100 COMPATIBLE RAM BOARD AND UPGRADE THE SAME BOARD TO A MAXIMUM OF 65K MEMORY IN STEPS OF EITHER 8K OR 16K AT YOUR OPTION BY MERELY PURCHASING MORE RAM CHIPS FROM SD COMPUTER PRODUCTS

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- MEMORY ACCESS TIME IS 375 ns
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  - 18 VDC 400 MA DC
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Imsai — Altair — S-100 Buss compatible, uses low power static 21L02-500ns fully buffered on board regulated, quality plated through PC board, including solder mask. 8 pos. dip switches for address select

*Add $30.00 for 250ns RAM operation



Z-80 CPU BOARD KIT

Complete Kit $139.

CHECK THE ADVANCED FEATURES OF OUR Z-80 CPU BOARD: Expanded set of 158 instructions, 8080A software capability, operation from a single 5VDC power supply; always stops on an M1 state, true sync generated on card (a real plus feature!), dynamic refresh and NMI available, either 2MHZ or 4MHZ operation, quality double sided plated through PC board; parts plus sockets provided for all IC's. *Add $10. extra for Z-80A chip which allows 4MHZ operation.



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THE VERSATILE FLOPPY DISK CONTROLLER

ONLY $149.00

FEATURES: IBM 3740 Soft Sectored Compatible. S-100 BUS Compatible for Z-80 or 8080. Controls up to 4 Drives (single or double sided). Directly controls the following drives:

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2. Shugart SA800/850 Standard Floppy.
3. PERSCI 70 and 277.
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34 Pin Connector for Mini Floppy. 50 Pin Connector for Standard Floppy. Operates with modified CP/M operating system and C-Basic Comptler. The new "Versafloppy" from S.D. Computer Products provides complete control for many of the available Floppy Disk Drives, Both Mini and Full Size. FD1771B-1 Single Density Controller Chip, Listings for Control Software are included in price.

FD 1771B-1 CHIP ALONE $39.95

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SIMPLE, STEP BY STEP LEARNING. CONSTRUCTION, PROGRAMMING, OPERATION, MEMORIES, INTERFACING, COMPUTING, AND CONTROLLING WITH AUDIO CASSETTE INTERFACE CAPABILITIES.

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(The Z-80 Based, S-100 Single Board Computer)

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This Powerful Threesome Operates Together to Form A Complete Computer for Your System.

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MK 4115 - 8K	19.45
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SUPER FLOPPY SPECIAL

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CTC for Z—80	14.95
8228 Sys. Controller	8.20
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4016	32	4069	23
4017	95	4071	19
4020	97	4076	97
4022	97	14518	1.10
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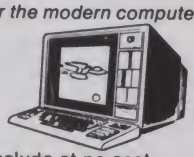
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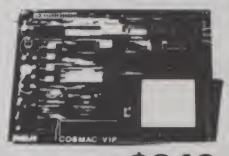
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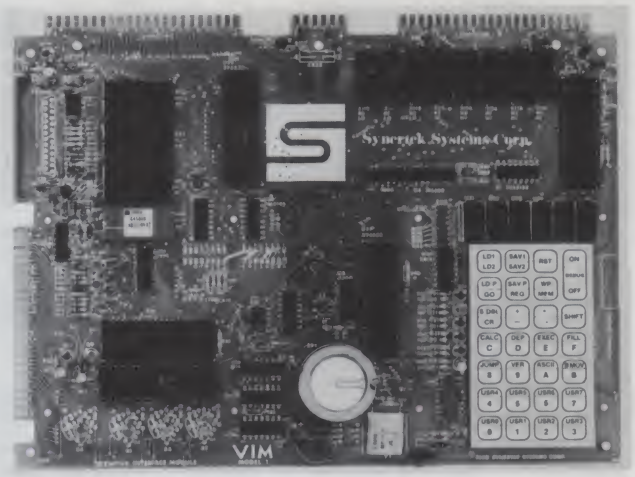
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**Because of a name conflict, the VIM-1 will now be called the SYM-1.

SYM-1 complete w/manuals **$269.00**
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This board requires a +5 VDC and +12 VDC, but has a DC to DC multiplyer so there is no need for an additional power supply. All software is resident in on-board Rom, and has a zero-insertion socket.

VAK-5 2708 Eprom Programmer **$269.00**

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This board using 2114 Rams is configured in two (2) separately addressable 8K blocks with individual write-protect switches.

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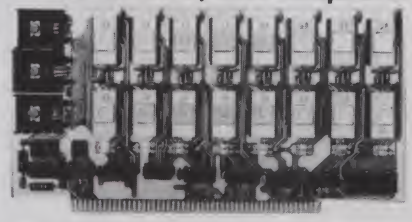
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2. Selectable wait states.
3. All address lines & data lines buffered!
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KIT INCLUDES ALL PARTS AND SOCKETS (except 2708's). Add $25. for assembled and tested.



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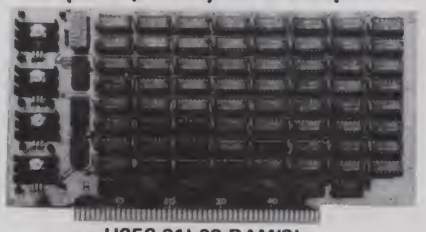
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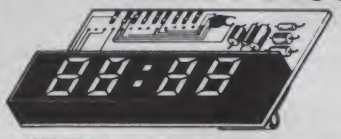
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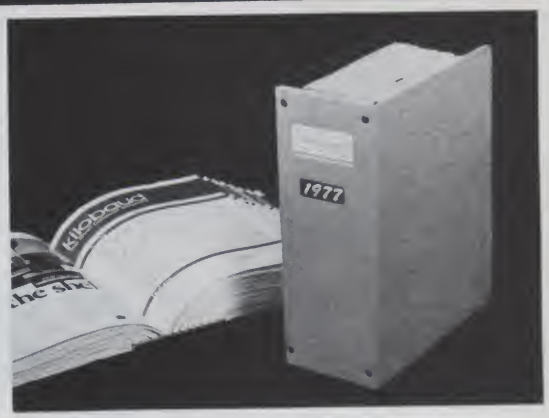
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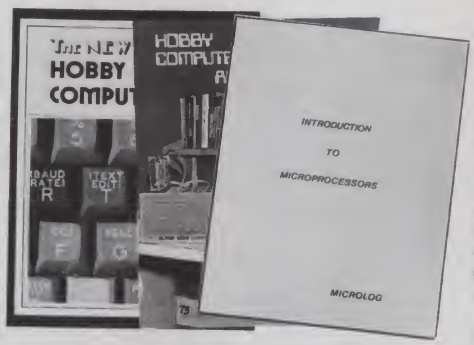
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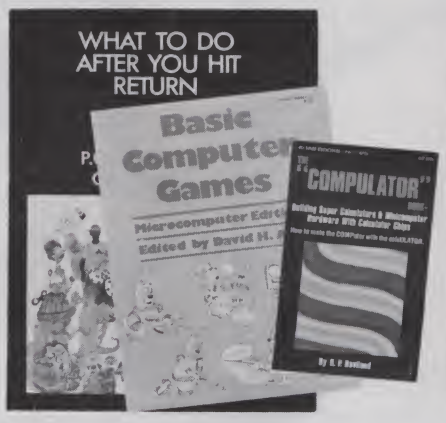


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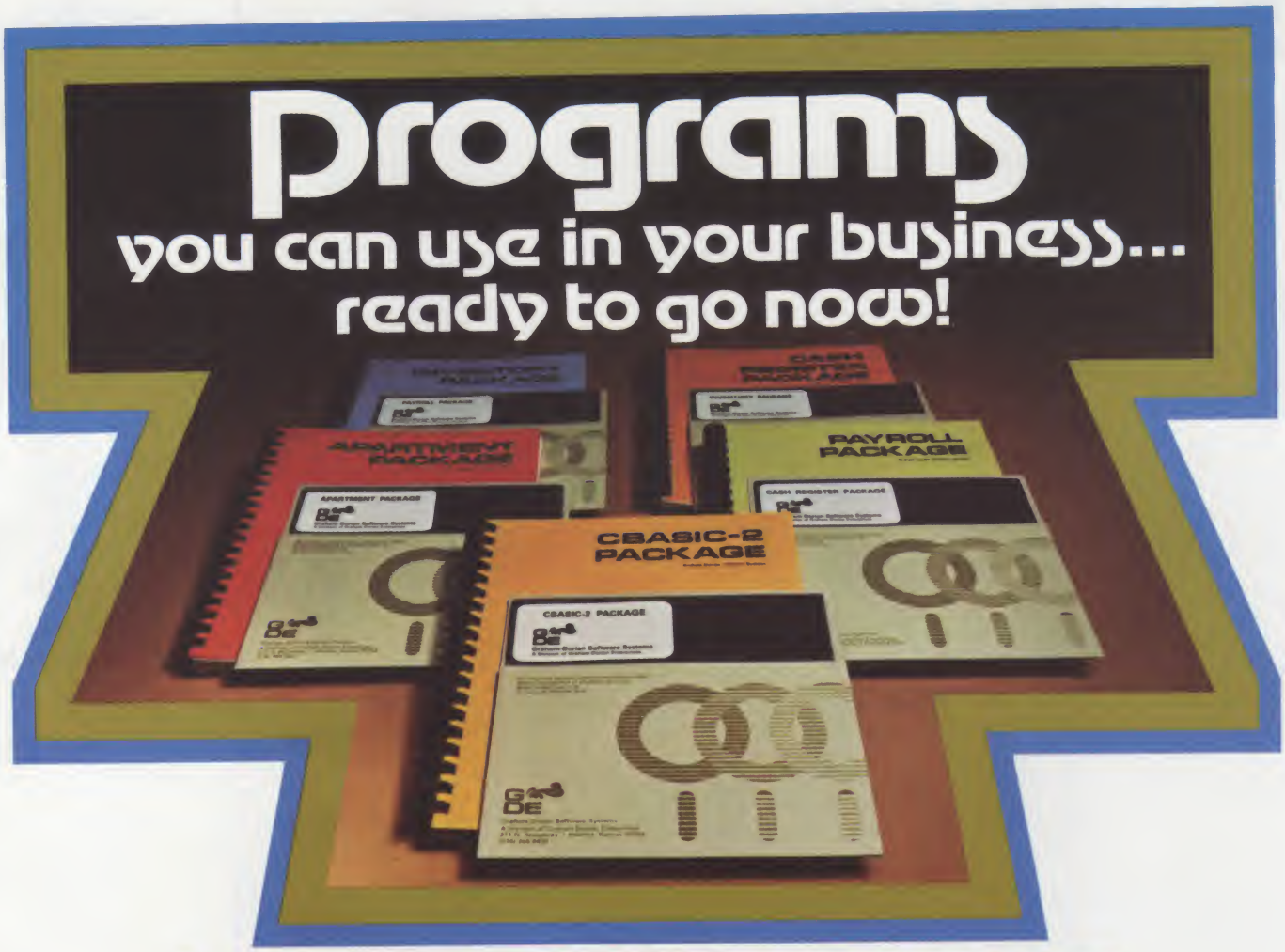
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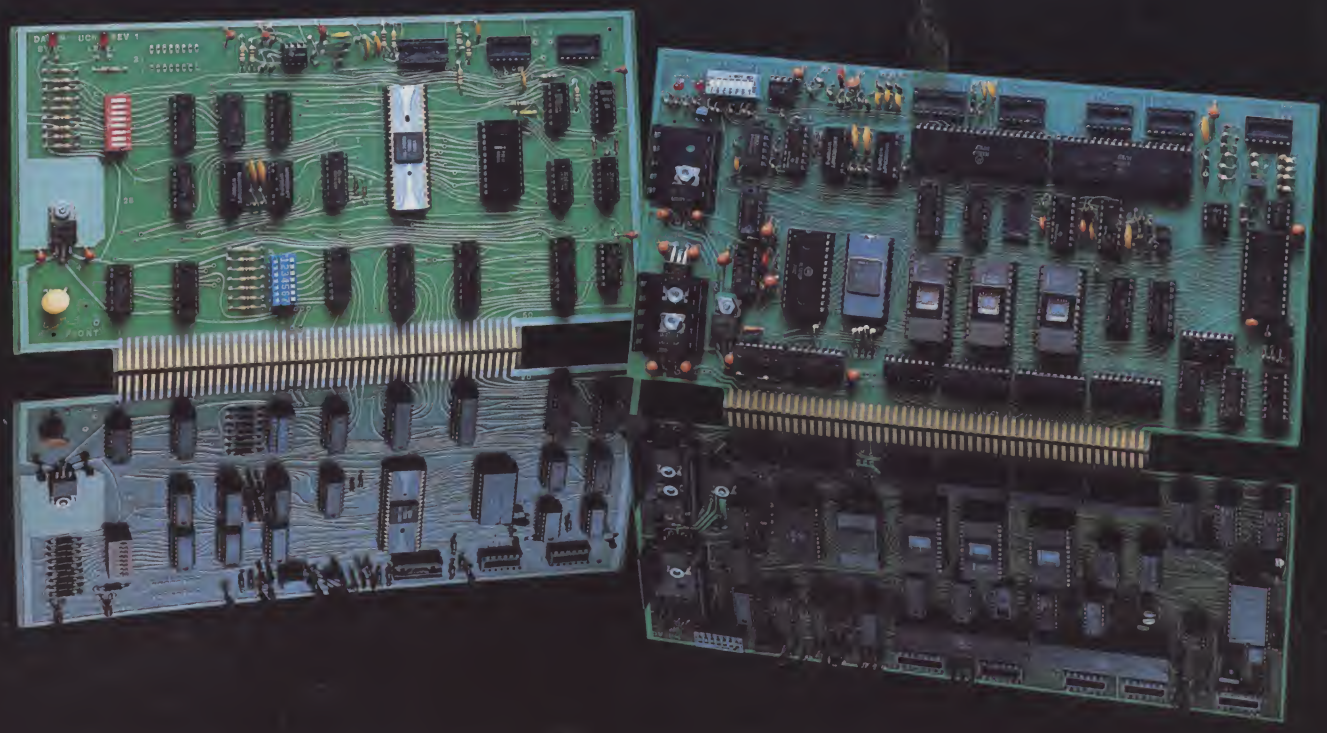
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